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ENGINEERING

DECORATION

CONSTRVCTION

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Light-houses at Ar-men and Heaux de Bréhat, France.
Offices of the Mutual Life-Insurance Company of New York.
Cape Cod Sketches. — No. II.

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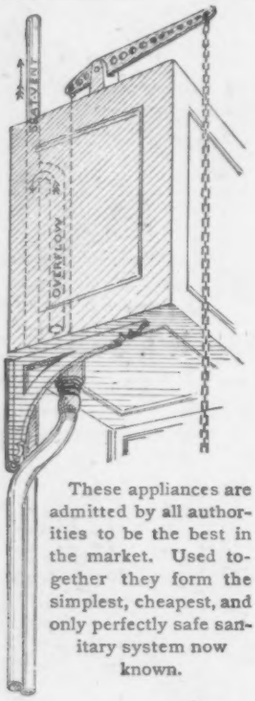

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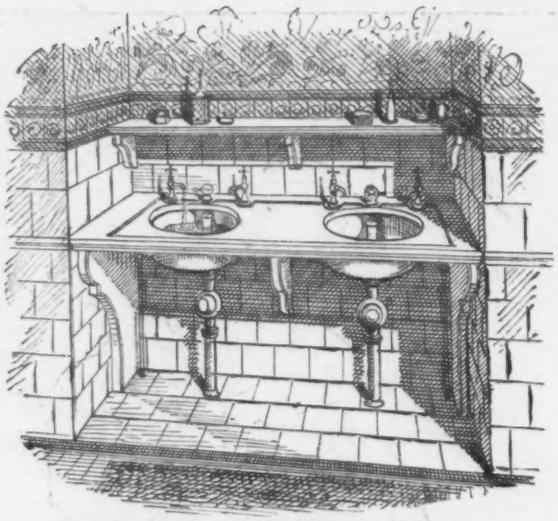

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A LITTLE book has recently been published by the American Economic Association on "*Coöperation in a Western City*," by Mr. Albert Shaw, one of the editors of the Minneapolis *Tribune*, which gives an account of a remarkable and most important industrial movement, which has been quietly going on in the pleasant twin city of the Northwest. Every one knows that Minneapolis manufactures more flour than any other city in the world, and consumes in consequence an enormous number of barrels, several million being used every year. The production of barrels is therefore a flourishing industry in the city, employing between seven hundred and eight hundred men, more than half of whom now work in associations on the coöperative plan, furnishing their own capital, making their own contracts for their goods, taking their own business risks, and dividing profits instead of receiving weekly or fortnightly wages. These associations have come into existence very quietly, have been managed in a sensible and undemonstrative way, and have been, as a rule, very profitable. So far, they have attracted neither attention nor interference from labor-reformers or enthusiasts of any kind, and it is doubtful whether the efforts of either of these would now be able to break them up, and drive their members back to a life of monotonous dependence.

BY the side of these remarkable associations, but in the sister city of St. Paul, have grown up a group of building associations unrivalled perhaps, by those of any community in this country, and possibly in the world. There is perhaps no writer on social science in any country who has not extolled the English building associations, with their admirable system of investing and lending money so as to promote the building of small dwellings. In Philadelphia, where the habits of the people favor them greatly, such associations are now very popular, and in Boston, mainly through the efforts of a single energetic gentleman, Mr. Paine, they are beginning to find favor, but in St. Paul, without special advocacy on the part of any one, they have attained a great extension, and it is said that one-fourth of all the families in the city are represented in them. At present there are forty associations of the kind there, most of them large ones, to judge from the account, which says that their receipts amount to eighty thousand dollars a month, or nearly a million a year. This income, which, although far surpassed by that of the great London associations, is astonishingly great for a town like St. Paul, in which building associations date back only about ten years, is annually invested in more than a thousand loans, mostly on small dwellings, and it is asserted that between eight and ten thousand houses, in St. Paul alone, have been built for their owners, mostly men of small means, by the aid of these loans.

DR. O. W. WIGHT, the energetic and clever health officer of Detroit, has designed and constructed a pest-house, or rather a hospital for contagious diseases, in the suburbs of that city, which is described in the *Sanitary News*, and well deserves the attention of architects. The plan of the structure, which consists of a cellular mass of fifteen rooms, eight being octagonal, connected by seven small square ones, although very economical, is open to the objection that the three inner rooms, one of which contains the bath-rooms and water-closets, while the two adjoining ones are devoted to convalescents, are rather badly situated for light and air, the only windows which they possess being twenty feet above the floor, opening over the roofs of the exterior rooms; while the convalescent rooms, which form the only passage-way between the baths and closets, and all the other rooms in the building, must be anything but pleasant places for weak and nervous persons to stay in; but the system of construction is admirable. Proceeding on the principle that everything like neglected hollow spaces or absorbent materials was to be avoided, Dr. Wight conceived the idea of building his hospital by the well-known method in use for constructing grain elevators. Seasoned pine planks, two inches thick and four inches wide, are laid flat, one above another, and spiked together, to form all the walls and partitions. The outside is covered with vertical boarding, nailed directly to the planks; but all interior surfaces are simply planed smooth and varnished. The walls thus formed are cheap, dry, non-absorbent, and to a considerable degree fire-resisting, and have the great advantage of being readily washed by a stream from a hose, without having the damp quality, and the propensity to condense a foul, clammy moisture on their surface, which belongs to walls of masonry covered with tiling or impervious cements. The windows are large, and divided into three sashes, of which the middle one is stationary, and the sashes are double-glazed. All the rooms are open to the roof, which forms a congeries of pyramids, each having the room under it for a base. The roofs are formed of plank, two and one-half inches thick, covered with tin. The floors are double, the under floor being of pine, with an upper floor of maple. The rooms are heated by low-pressure steam, on the direct-indirect plan. The whole cost of this ingenious and serviceable structure, which will easily accommodate fifty patients, was only eleven thousand dollars.

MR. JAMES WEBB, one of the oldest and best-known building contractors in New York, died last week in his eighty-seventh year. Mr. Webb was for many years employed by the great New York families of the Astors and Van Courtlandts, and remembered perhaps more of the city in the early part of the present century than any New Yorker of the present day. His first contract, after he had finished his apprenticeship as a mason, was for a house for one of the Van Courtlandts, who then owned and kept negro slaves. This house was in Morris Street, not far from Trinity Church, which was then a fashionable locality. Soon after this, he was called upon to build a "country house" for the mayor of the city, Philip Hone, at the corner of Beekman and Gold Streets. This house, though now buried in the heart of the busiest part of New York, still stands, and bears the initials of the mayor's name on the gable. Mr. Hone's office was in Whitehall Street, so that he had a walk of a mile and a half, or thereabouts, to his new suburban residence. It was about this time, we believe, that the New York Hospital was built on Broadway, below Worth Street. Although the location of the hospital was five miles below the present fashionable quarter, it was considered sixty years ago so far out in the country that the hospital physician, who lived in the city, which then extended little north of Wall Street, was granted the use of a horse and carriage, at the expense of the hospital funds, to take him to and from his work. After "Greenwich Village" had been pretty well built up, and the Bowery, on the other side of the town, had lost its suburban character, a bold step was taken in crossing the Canal, which was then a creek, connecting the two rivers, and spanned by a bridge at Broadway; and building recommenced on the higher ground on the opposite shore. The two Astor brothers, William and John Jacob, built, by the hands of Mr. Webb, comfortable up-town residences on Broadway and Lafayette Place, and fashion followed them to Lafayette Place, Astor Place, Clinton Place and Washington Square. In their turn, these streets have been given up to business, and the tide has

moved forward until the houses which Mr. William B. Astor's sons built, with pretty gardens attached to them, on Fifth Avenue and Thirty-third and Thirty-fourth Streets, about a mile and a half beyond the home of their childhood, are now nearly surrounded by plate-glass shop-windows and gilt signs. It seems strange that in one man's life-time a great city should be so completely transformed; yet New York is growing faster now than ever before, and our children will probably listen some day with amazement to our stories of the rocks and shanties which are fast disappearing from the neighborhood of the upper Central Park.

THE most astonishing boiler explosion yet described seems to be one which occurred last month in Pennsylvania, where a locomotive, with four men upon it, blew up, just after it had been thoroughly repaired. According to the *Scientific American*, this engine, which was of the heaviest "consolidated" type, was built at Schenectady three years ago, and ought, therefore, to have been just about in the prime of its life. The tubes had begun to burn out, and the engine was sent to the repair-shop, where one hundred and twenty, out of the two hundred and twenty tubes which the boiler contained, were replaced by new ones, and a large number of bolts and rivets were renewed. The boiler was then tested by hydraulic pressure, but only to one hundred and fifty pounds, the intended maximum working pressure being one hundred and twenty-five pounds. When the work was done, steam was raised for a trial trip, and the engine was moved out of the shop and upon a side track, and the engineer was ordered to run up and down the track a few times, to see that everything worked smoothly, and meanwhile to set the safety-valve at one hundred and twenty-five pounds. The steam-blower was turned on, to raise the pressure to the required limit, and the machinist climbed to the top of the cab, where he sat, screwing down the safety-valve, and waiting until the engineer should give him the signal that the steam-gauge showed the pressure desired. Some of the by-standers noticed that the blower was kept in operation an unusually long time, and a man on a train which happened to pass remarked that the sound of the blower showed that there was a high pressure on, but the gauge seems not to have registered the specified maximum, and nothing unusual was observed until a pipe which had been repaired, gave way, and the next instant the boiler was torn into two pieces; the front and upper portion, with the machinist who was at work on the safety-valve, and two other men who were standing on the engine, being hurled into the air, at an angle of about thirty-five degrees with a vertical, so far that it looked like a speck in the sky. Later, this part, with the bodies of the three men near it, was found a quarter of a mile away, on the other side of the crest of a hill four hundred feet high. The body of the engineer, who was in the cab, was found by itself, half a mile from the others; but of the rear portion of the boiler no portion has yet been discovered. The tubes were scattered in all directions, one having been driven entirely through a neighboring house, and some fragments have been picked up a mile from the scene of the explosion. The only explanation of the accident which has been given is that the cock in the pipe connecting the steam-gauge with the boiler had been in some way nearly closed, so that the gauge only registered a fraction of the real pressure in the boiler.

THE *Builder* gives an account of some novel applications of cement concrete, which have recently been made by Mr. David Wilson. The most curious of these is perhaps to be found in the use of the concrete for making telegraph-poles, which are now regularly made for the markets, and are found strong, durable, and very little heavier than wooden ones. These concrete poles are made, it is hardly necessary to say, upon a skeleton of wire netting, which is set up in a cylindrical mould, having a core set inside. The concrete is then poured in at the top of the cylinder, and allowed to harden; and if the materials are good the poles are very serviceable. Wooden blocks embedded in the concrete serve for attaching the arms. The same principle is applied to the formation of sewer-pipes, which are easily made of nine feet in diameter, and, when formed over two cylinders of wire netting, are very strong, durable and cheap. Cylindrical sections made in the same way, with a bottom added, are found to answer admirably for water-tanks, needing no painting, and being free from any liability to rust or decay. The American, Mr. Thaddeus Hyatt, was, we believe, the first to point out that the coefficient of expansion by heat was nearly the same for Portland cement as for iron; and to experiment on combinations of cement-concrete and iron, by which the metal was employed to resist the tensile strains, leaving the concrete to sustain only compression; but, beyond the publication of a very interesting book on the subject, nothing seems to have resulted from his experiments. In practice, perhaps some further study is needed to devise means for enabling concrete so combined with iron to resist shearing strains, as well as those of tension and compression, before it will be available for sustaining severe transverse strains; but this advance ought not to be very difficult. To illustrate, by an example, the direction which experiment might, perhaps, take with advantage, we may suppose a floor, intended for carrying heavy loads over a wide span, to be made on Mr. Hyatt's proposed system, by casting it, on a platform erected for the purpose, in a single piece of Portland cement concrete, having a row of iron rods embedded in it, near the bottom, each rod being armed with a washer, or cross-bar, to prevent it from being dragged through the mass by the tension due to a bending strain. On M. Hyatt's theory, if the number of bars were properly proportioned to the concrete, the tensile strength of the part of the mass below the plane of the neutral axis might be made nearly equal to the resistance to crushing of the part above the neutral plane, thus giving an immense resistance to bending; but the resistance to shearing, although this has, we believe, never been determined for concrete, would, as concrete is usually made, be small, and the floor would fail, by breaking through near the supports, long before it could bend enough to try the tension-rods seriously. It would, however, be perfectly practicable to increase the resistance to shearing of the concrete in a great degree, by a suitable choice and disposition of the aggregate. If this, for example, instead of an incoherent jumble of little angular fragments, were to be made of sheets of slate, bedded one above another in the cement matrix, with joints carefully broken, its strength in this particular would be enormously increased, and rods or wires might well be used to give the mass the tensile strength which would then be the only quality needed to give it the resistance desired. Even without the iron rods, such a concrete would have an immense transverse strength. We remember reading, long ago, about certain floors which were made in Germany by laying flat tiles on a temporary platform, then spreading a coat of mortar and laying a second course of tiles, breaking joint with the first; and following this with a third and fourth, laid in the same way. On removing the staging, after the mortar had dried, the floor was found strong enough to sustain the traffic of a dwelling-house over wide spans; and with our excellent cements it ought to be possible to improve considerably on this construction. Such a floor would have the great advantages of exerting no thrust on the walls, and of giving a smooth ceiling underneath, while its weight, being divided uniformly all around its perimeter, would be in many cases more easily and more safely borne than that of a brick or terra-cotta floor carried by iron beams.

THE *Weiner Bauindustrie-Zeitung* says something about the framing of valuable drawings or engravings which is well worth knowing. According to this it is very injudicious to frame such things, as is usually done, by dropping the glass into the rebate in the frame, laying the drawing upon it, pressing this close against the glass by a board, and then pasting a sheet of brown paper over the back of the whole affair, to keep the dust out. With etchings or engravings the oil of the ink gradually exudes from the lines upon the glass, and is carried by capillary attraction over the surrounding paper; while changes of temperature, or the bringing of the picture from a cold to a warm room, condense moisture upon the inner as well as the outer surface of the glass, dampening the paper in contact with it, and either staining it or preparing it for the germination of the spores of moth or mould, which easily get behind the glass through the rebate, in which it fits loosely. To avoid these sources of deterioration, the glass of the frame in which valuable drawings are to be placed should be first prepared by pasting thick paper around the edges, so that when set in the rebate it will fit so tightly that no particle of dust can get through. The drawing should then be pasted by the extreme edges on a mat, stretching it very lightly, so that it will be held slightly away from the glass, and strips of paper then put in the rebate, between the mat and the glass, and around the edges, so that no dust can get in from the back; and, last of all, a sheet of well-sized paper is to be pasted over the back of the frame.

THE WATER-SUPPLY OF BUILDINGS. — I.

EQUALLY important with a thorough system of drainage is an abundant and uniform water-supply. Each is dependent upon and necessitated by the other.

Before water-carriage became general among civilized races as a means of removing household refuse, an efficient system of water-supply was to be considered as simply a matter of convenience. It has now become one of necessity, for without it, thorough flushing is practically unattainable, and plumbing work becomes a source of danger, while with it plumbing may be rendered as safe as any other branch of building, and all its comforts and hygienic advantages may be enjoyed with entire confidence, and in absolute security.

Just as we have already shown to be the case in drainage, however, so in water-supply, there is a tendency at present to undue complication in the work. Here again, money which should be spent on better and stronger work is wasted upon a vast amount of unnecessary material. The house-owner is discouraged at the complexity of piping and superabundance of apparatus to be used, and is "forced to 'cut down'" in the quality as well as in the quantity of his work.

We hope to be able to show in these articles ways in which this unnecessary complication and expense can be avoided.

VARIOUS METHODS OF WATER DISTRIBUTION.

The water-supply may be distributed in a house in three different ways, *i. e.*, either directly to each fixture from public mains, or indirectly from a storage-tank; or through a combination of these two systems. Where a storage-tank is used, it may be fed either by the public main, or by pumping from a well or cistern. The first is employed in cities where public water-works are carried out. The last in thinly-settled country districts and in isolated dwellings, where a public water-supply would involve much greater expense to the individual than private wells and cisterns.

We shall take up first the consideration of

WATER SERVICE IN CITY HOUSES.

The Storage-Tank. — The chief desideratum here is to obtain a constant supply and uniform pressure at each outlet and fixture; the quality of the water furnished by the public service being a matter over which the individual has no control after the water-works have been completed. Inasmuch as the quality of the water provided by the authorities is usually suitable for all ordinary domestic purposes, the construction of auxiliary cisterns for collecting rain or well water is seldom required in cities. Not so with the quantity and uniformity of the supply. From numerous causes the water-pressure must constantly vary. Fluctuations in the rainfall, the source from which the mains are directly or indirectly fed, and in the consumption of water at different seasons of the year and hours of the day; alterations or repairs in the pipe system constantly occurring; all have their effect on the pressure, and render, under the refinements of modern plumbing, a direct reliance upon these main pipes, without the addition of a storage-tank, very unsatisfactory. Where no storage-tank is used, it often happens that no water can be obtained in the upper stories of a house at times, when water is being drawn anywhere below. In the case of lavatories this may be nothing more than a source of inconvenience; but in the case of water-closets it may entail considerable danger, inasmuch as the closets will be left unflushed by careless or forgetful persons, if at the time of using, the flush cannot at once be obtained. Moreover, the danger is further increased by the fact that, when the water-closet valve is opened under such circumstances, foul air may be drawn into the supply-pipes from the water-closet room, to pollute the drinking water.

Another danger of the direct-supply system is the liability to rupture of the pipes under the severe strain brought suddenly upon them, when a faucet is shut off under a heavy pressure of water. This heavy pressure will always tend to wear out the faucets as they are generally made, and make them leak in a short time. The leak involves a repair, and a repair when there is no storage-tank, often involves an entire disuse of the plumbing fixtures until it is completed. Should the work of reparation occupy considerable time, there is danger of the water-closets becoming offensive and nocuous for want of sufficient flushing. Should the repair be required in the public mains outside of the house, the unforeseen shutting-off and subsequent turning-on of the water may occasion the bursting or collapse of the kitchen boiler.

Thus we find that the direct-supply system has many serious disadvantages and dangers, and a storage or distribution tank should, in all cases be used, in city as well as in country houses, without exception. It is generally supposed that the tank system must be more expensive than the direct-supply, but we shall find that this is an error, the reverse being really the case.

We have then, for our first principle of water-supply, that every house should be provided with such a tank. It must be understood, however, that it does not follow from this that all the water used in the house should be drawn from it. The drinking and cooking water, and sometimes the cold water for lavatories should be taken from the pipe which supplies it, rather than from the tank itself, which should be reserved for the supply of water-closets and of hot-water for lavatories.

MATERIAL AND GENERAL ARRANGEMENT OF THE SUPPLY-PIPES.

The material now in general use for direct as well as tank supply is lead. From its cheapness and facility of working, it has long been the favorite material with plumbers, and for tank distribution-pipes, it has no serious objection.

For conveying drinking and cooking water, however, sanitary considerations sometimes preclude the use of unprotected lead when the water is of such a character as to act upon it. The nature of the water in this respect in any locality must be obtained from competent local authorities. Other defects in lead for supply as well as for waste pipes are its softness and great weight which attributes cause it to "sag" and "crawl," after being put in place. It has little toughness and no elasticity, and its use for supply-pipes seems destined very soon to be superseded in a great measure by iron, as it already has been in the main waste-pipe system.

Protecting Lead Pipe. — A protective coating, more or less effectual, may be applied to lead pipes by filling them with a weak solution of phosphate of soda, which precipitates upon their inner surfaces an insoluble coating of phosphate of lead. Or sulphate of potassium or sodium may be used, forming a precipitate of sulphate of lead. These chemicals produce quickly the same effect of protection as would be produced slowly by the natural flow of hard water through the pipes.

Tin-lined Lead Pipes. — Lead pipes may be protected more reliably by lining them with a stout coat of tin, the salts of which, formed by water, are also insoluble and harmless. The interior lining of tin should, however, be thick, and in fact, a continuous and independent pipe forced into permanent contact with the lead by hydraulic pressure. This pipe is considerably more expensive than lead pipe, and requires greater care in putting together than the latter, to avoid injuring the lining.

Tinned brass ferrules or couplings should always be used in jointing. These are furnished by the manufacturers, with the pipe.

A prejudice has arisen against the use of this pipe, on account of the poor quality of much that has been sold. The coating of tin has been too thin, and the jointing improperly done. The result of this is that the lining easily breaks, melts or wears off in places, leaving the lead exposed, and the two metals then produce, in the presence of water, a galvanic action, which is supposed to seriously hasten the destruction of the pipe.

Pure Block-tin Pipes are perfectly safe from a sanitary point of view, but they are difficult to handle and repair. These drawbacks and the great cost are sufficient to limit the use of block-tin to very rare occasions.

Brass and Copper Pipes are easily attacked by water, and the resultant salts are poisonous. Hence, if used for the conveyance of drinking-water, they should be tinned on the inside. Nevertheless, the tin coating, as usually applied, has no appreciable thickness, and will not long protect the brass or copper from corrosion. They are, therefore, not to be recommended for conveying drinking or cooking water in any case. Brass is still very largely used for hot-water lavatory service, in preference to lead, as it is better able to stand the alternations of heat and cold to which this service subjects them. Lead in this case would soon be destroyed by this action.

Wrought-Iron for supply-pipes has, besides its sanitary advantage, that of great strength, toughness, cheapness, and facility of jointing. Although instances have often been cited of unprotected wrought-iron service-pipe lasting for from ten to

twenty years, we know that it requires some permanent coating to render it in all cases safe against destruction and clogging. Water coming through iron pipes is uninjured for drinking, and indeed is sometimes improved.

An enormous amount of time and ingenuity has been spent in the search for a permanent protective coating for iron which should be at once cheap and reliable; but until within the last few years with no very encouraging results. Galvanizing or zinc coating was, when first introduced, thought to have solved the problem, but a great many kinds of water are found to decompose the zinc and yield with it poisonous salts; moreover, imperfections in the coating, difficult to avoid, cause a destruction of the iron much more rapid than would be the case were no coating applied, so that this means of protection is now regarded as altogether unsatisfactory.

Tin-coated iron has never met with success, on account of the difficulty of making the tin adhere to the rough inner surface of the pipe. Tin-lined iron pipe, however, in which an independent continuous pipe of tin is inserted within the iron, the two being brought into close contact by hydraulic pressure, forms, if properly put together, a very good supply-pipe. As with the tin-lined lead pipe, great care should be taken in jointing, and special tin-lined iron fittings furnished by the manufacturers should be used for all joints. This pipe, however, can scarcely be classed as *coated* iron pipe. It is practically nothing more than a double pipe, of tin and iron, of which the outside receives no protection. The pipe is comparatively expensive, and if not very accurately jointed, galvanic action assists natural corrosion and hastens destruction. It has never found great favor among plumbers, and is rarely used.

From glass-lined iron pipe much was expected when it was first introduced, a few years ago; but it is difficult to cut with the ordinary tools used by plumbers, and, largely on this account, it has never become popular. This difficulty, together with its expense and the brittleness of the lining, have been considered so great that its use has for some time been practically abandoned.

Asphalted wrought-iron pipe has been much used, but cannot be considered as a permanent pipe. For hot-water conveyance it is not well suited, on account of the tendency of the hot water to destroy the coating.

Enamelled iron pipe varies as much in character as in the variety of ways in which it is made. When new, the different kinds resemble each other so much that it would be impossible for the ordinary observer to distinguish between the good and the bad. With some the enamelling consists of nothing more than a shiny but perishable coat of baking varnish. With others the pipe is coated with a thick, hard, glossy elastic enamel of great durability.

The Bower-Barff Process.—There is another protective treatment of iron totally different in character from any of the preceding, which appears to have met the problem before us in a most satisfactory manner. No foreign substance whatever is added to the iron, except oxygen, which converts its surface into a magnetic oxide. This coating has the remarkable power of effectually withstanding, apparently indefinitely, the corrosive action of air and water, hot or cold, fresh or salt, under most trying conditions.

The formation of the magnetic oxide is accomplished by subjecting the iron to the action of superheated steam in furnaces especially constructed for the purpose. The cost of treatment is very low, and, so far, the results have answered every expectation, and been eminently satisfactory. The pipe is put together like ordinary gas-piping, with screw-joints, except that only oil need be used at the threads, instead of red or white lead. The oil soon becomes sufficiently hard to make a tight joint, and is free from the danger of poisoning the water.

We believe that this pipe is destined to supplant all others for the conveyance of water. There are many places in plumbing, as we shall show, in which its use would be safe beyond all question, and would effect a great saving in the cost of the work. The writer has for some time been conducting a series of experiments on iron thus coated, the results of which tests will be given farther on.

[To be continued.]

Proposed Restoration of Hereford Cathedral.—It is proposed that the Herefordshire memorial of the Jubilee shall take the form of a complete rebuilding of the west end of Hereford Cathedral, which it is estimated will cost £80,000 if the work be thoroughly carried out. The dean and chapter expended £50,000 in the elaborate restoration of the other parts of the cathedral, which was finished in 1863, after having been in progress for more than twenty years.

ANCIENT AND MODERN LIGHT-HOUSES.[1]—VII.

LIGHT-HOUSE OF HEAUX DE BRÉHAT.

On the coasts of France, light-houses were needed, as in England, on difficult sites, and it is interesting to compare the different manners in which similar problems were solved in the two countries. I have selected the Light-house of Heaux de Bréhat as one comparative type; it is situated about three miles from the most northernly end of the Peninsular of Brittany, on the plateau of Heaux de Bréhat, which consists of a porphyritic rock about five hundred and sixty yards in diameter at low tide, and entirely submerged at high tide except a few scattered projections.

Here the currents are very strong, at times running as high as eight knots an hour, and the sea in gales attaining an extraordinary violence.

The tower instead of being placed on the highest part of the rock, was situated at a place near which landings could most conveniently be made in order to reduce as much as possible the cost and delay of landing the materials used in its construction.

At the Isle of Bréhat near by, a natural harbor was improved; and the storehouses and work-shops were built. All the stones were cut here, and in order to insure accuracy each course was laid out on a platform; the stones were then shipped on barges of about forty tons burden, each stone carrying its number, its sling, and surrounded with straw mats to prevent its edges being chipped. The stones were unloaded, and placed by means of a series of derricks, which passed the stones to each other. A flying scaffold was also used for the convenience of the workmen, and was carried up as the work progressed. It consisted of a series of small fir trestles clasped against the tower by means of two chain bands which were tightened by jack-screws. When the scaffold was to be raised, the men stood on the masonry; the screws were loosened, each man seized a trestle, and at the word of command all lifted together. The chain bands were then retightened; the entire operation did not take more than half an hour.

The accompanying drawing, taken at low tide, shows how the work was carried on when the tower had reached the height of about one hundred and thirty-five feet above the rock. It was important that the men should live on the rock, so that they could be usefully employed, even during bad weather.

No matter how well and carefully the stones might be prepared, they had to be finished on the spot; and notwithstanding that arrangements had been perfected to assure rapidity in the landing of material, it was at times impossible to lay all of the stones of a cargo during one low tide.

Two adjacent slender peaks, near the centre of the plateau with their summits almost twenty feet above the highest tides, offered a good site for the erection of the necessary buildings. The space between them was filled with loose stone retained in place on one side by a vertical wall, and on the other by an inclined plane, both built of heavy blocks of stone laid in cement. A nearly square platform was thus made about thirty feet on the side, on which was erected a stout frame building, well anchored to the rock, and containing storerooms, a small forge, and rooms for the engineer, foremen and workmen. The building was surmounted by a small tower, from which was shown a temporary light. In this building were accommodated sixty men, who worked on the rock as soon as it was uncovered by the falling tide, and who found it their only refuge when the tide again rose.

In the light-houses at Eddystone and Bell rock, the lower courses were bonded together in a complicated manner by means of dovetails, and were held to each other by numerous iron or wooden dowels; at Skerryvore there was a departure from this system, which in addition to the expense it entails, materially retards the work at its critical stage. At the light-house of Bréhat there was a still farther departure from precedent, and it was decided not to fasten each stone separately; but to limit the quantity of masonry to that which could be put in solidly during one low tide.

Each course was divided into a certain number of sections or keys, each of which was connected by means of four small granite blocks;

[1] Continued from No. 576, page 16.

fitted in each course, and placed in the angles of the sections. The angular stones belonging to the exterior facing, being thus kept in place, form tie pieces; supporting the facing stone which come between them, and are attached to those which compose the sides of the key by means of dovetails let in their whole thickness. Finally, the interior face, maintained upon the preceding course by two stones, is also held by the stone belonging to the course above, which being placed across the joint allows the tie pieces on that side to be suppressed. The perimeter thus being made firm, artifices of construction were not required for the interior; and in the lower courses where it was necessary to finish rapidly, and where there was considerable surface, it was completed in rubble masonry. This method was entirely successful; in no case was any damage sustained when an entire course could be finished before the return of the tide, which was generally accomplished; it was the same even when the work had to be discontinued, without having to place any other stones than those of the facing, from which the work was always commenced; occasionally they were not prepared in time, and some stones were raised and moved a short distance out of place. These were readily reset, and the method was found advantageous both as to economy and rapidity of execution.

The porphyritic rock on which the light-house is built is of extreme hardness, and rapidly wears out the best tools; but in many places it is fissured, and the sea breaks off small fragments. This prevented the establishment of the foundation on the same level throughout, and it was found necessary to divide it into several parts so as to avoid any chance of its being swept away, and also to diminish the cost of excavation.

In the centre a circular space fourteen feet in diameter, corresponding to the interior hollow of the tower, was left untouched; outside this an annular space thirty-nine feet in exterior diameter was levelled off six inches below the lowest portion of this part of the plateau; then at the circumference there was hollowed out a trench forty inches wide, of a depth varying with the condition of the rock so that no part of the base should be protected by less than sixteen inches in height of compact porphyry.

The light-house consists of a tower with an interior cylindrical opening fourteen feet in diameter, and one hundred and fifty-eight feet high from its base to the lantern floor. It consists of two principal parts, the lower trumpet-shaped and solid to three feet four inches above the highest tides, the upper, considered as standing on an immovable base has a degree of lightness about the same as that usually given to towers of the same height built on shore; the thickness of the walls is four feet four inches at the bottom and decreases to two feet ten inches at the top under the cornice.

The interior is divided as follows: the two lower stories are storerooms, the four above are the kitchen and keeper's quarters; the seventh, fitted up rather better than the rest is a room for the engineer; the eighth is a watch-room, and above that is the lantern-room.

The casing of the stairway is built in the tower wall on one side, and forms on the other upon the cylindrical opening of the tower, a projection, the recesses on each side of which are utilized as closets. The entire work is built of granite of fine, close grain, and of a bluish tint. The arches are built of brick, made according to pattern, except the one supporting the floor of the service-chamber which is of concrete, the brick not arriving in time.

The cost of this structure was $106,365 exclusive of the lantern and illuminating apparatus.

LIGHT-HOUSE OF AR-MEN.

More difficult than the preceding was the building of the foundation of the light-house of Ar-men, France. The island of Sein is situated on the western extremity of the department of Finisterre, in the northwest part of France, and extends in a westerly direction by a succession of reefs to a distance of nearly eight miles from the island. The tops of some are elevated above the highest tides; others are alternately above and below the surface of the water, while the greater number are always submerged. They constitute a sort of dam, whose direction is nearly perpendicular to that of the tidal currents, and the sea constantly breaks over them with great violence.

In April, 1860, the Light-house Board of France determined that the subject should be thoroughly investigated, in order to know if it would be possible to erect a first-order light-house on one of the rocks not covered by the sea and as near as possible to the end of the reef. Next June this action was approved, and a commission of engineers and officers of the navy were charged with the duty of making surveys of the locality.

In July this Commission had made a careful examination of the local conditions, and ascertained that there were three rocks at the extremity which projected above the water, even in strong tides. Of these rocks, which are called Madion, Schomeor and Ar-men, the two first are nearly covered, while the third rises to about five feet above the lowest ebb-tides.

The state of the sea had not permitted the Commission to land, or even to go alongside Ar-men, but from the view that could be obtained its dimensions appeared insufficient for the construction of a great light-house, and landings seemed impossible, even in the most favorable weather.

The Commission, therefore, unanimously recommended the selection of the Rock Neuerlach as a site, about five miles inward from the end of the reef. This recommendation was not approved by the Board, as it did not tend to ameliorate the existing state of things sufficiently for the needs of navigation, and the Ministry of Marine was requested to order a thorough hydrographic survey of the end ofthe reef.

Various circumstances retarded the execution of this work. In 1866, M. Ploix, engineer and hydrographer, was sent to the spot, and though he was not able to gather all the necessary information, still, his investigation was sufficient to enable the Board to decide upon a plan — his conclusion was that Ar-men was the proper site. In true French style he said, "It is a work exceedingly difficult, almost impossible, but considering the paramount importance of lighting the reef, we must try the impossible."

The currents passing over the reef are most violent; in high tides their speed exceeds eight knots, and in the calmest weather they cause a strong chopping sea as soon as a breeze meets them. It is only possible to go alongside the rock during very gentle winds between the north and east.

The impossibility of anchoring a floating light was recognized as much on account of the great depth of water as of the fact that the bottom was thickly studded with rocks, about which the anchor-chain would be fouled.

Owing to the great difficulty of construction the project of establishing an iron structure resting directly on the reef was not entertained, the Board finally deciding that a solid masonry foundation must be established of such dimensions as would be suitable for the construction of a light-house.

The size of the rock, which was of tolerably hard gneiss, was about twenty-five by forty-five feet at low tide; the surface was very unequal and divided by deep fissures, and, while almost perpendicular on the eastern side, there was a gradual slope on the western.

The following mode of construction was decided upon: To bore holes a foot deep, and three feet four inches apart, all over the site of the intended structure, with other holes outside this limit, for ringbolts necessary to hold boats coming alongside. The first set of holes was to receive wrought-iron gudgeons, to fix the masonry to the rock and to make the construction itself serve to bind together the various parts and the fissures, and thus consolidate a base whose precarious nature gave rise to some misgivings. Other additional gudgeons were to be used as became necessary, and strong iron chains were to be introduced into the masonry as it progressed, so as to prevent any possible disjunction.

For the work of boring the holes the services of the fishermen of the Seine were called into requisition, as they were familiar with all the rocks of the reef, and were in a position to take advantage of every favorable moment. After many difficulties, they accepted a contract, the Government agreeing to furnish tools and life-belts.

In 1867 work was vigorously begun and every possible chance was seized. Two men from each boat landed on the rock, and, provided with their life-belts, lay down upon it. Holding on with one hand, they held the jumper or the hammer in the other, working with feverish activity, the waves constantly breaking over them.

One was carried off the rock, and the violence of the current bore him a long distance from the reef, against which he would have been dashed to pieces, but his life-belt kept him afloat and a boat went to fetch him back to work. There is no record as to whether he was docked for lost time.

During the building of Minot's Ledge light-house, near Boston, a similar accident happened, and though the man was saved he lost his tools. To prevent a recurrence of this disaster, he fastened the tools to his wrists with long cords. Another heavy wave washed him off, and he floated away as before, with the exception that this time his feet instead of his head appeared above water; however, he was rescued in time, but not in a condition to do any further work that day. It is unnecessary to add that he tied himself to his tools no more.

At the close of the season's work at Ar-men, seven landings had been made and eight hours' work accomplished, during which time fifteen holes had been bored in the higher parts of the rock.

The following year more difficulties were encountered, as it was necessary to commence on the part hardly above water; but the experience gained was valuable, and the fishermen were stimulated by higher wages. The season proved favorable. Sixteen landings were effected, giving eighteen hours of work, during which forty new holes were bored, and they even succeeded in partially levelling and preparing the rock for the first course of masonry.

The actual building of the masonry was not commenced until 1869. The galvanized wrought-iron gudgeons, forty inches long and two and four-tenths inches square, were fixed in the holes, and the masonry of small undressed stone was laid in Parker-Medina cement. A cement of the most rapidly hardening character was essential, for the work was carried on in the midst of waves breaking over the rock, and which sometimes wrenched from the hand of the workman the stone he was about to set. An experienced sailor, holding on to one of the iron stanchions, was always on the watch to give warning of such waves as were likely to sweep the rock, when the men would hold on, head to the sea, while the water washed over them. On the other hand, when he announced a probable calm, the work went on with great rapidity.

All the workmen were supplied with life-belts, as the fishermen had been, as well as with spike-soled shoes to prevent slipping. The foreman, also, and the engineer, who by their presence always encouraged the men, were similarly furnished.

When a landing was practicable, the stone and small bags of cement were landed by hand, and care was taken to dress the surface of

the masonry before commencing a new course. The cement was used pure, and of necessity mixed with sea water. Since 1871, Portland cement was substituted for Parker, the resistance of the former to the action of the water having been found superior to the latter, and the stonework at the foot of the tower was preserved by refilling the interstices with this material.

As the tower grew in height, the work naturally proceeded more rapidly, but it was not until 1881 that the structure was finally completed, and the light shown.

The light is of the first order, fixed white, with its focal plane ninety-six feet above the level of the sea. This limit might have been exceeded so as to make it of the usual height of a first-order tower, had it not been for the insufficiency of the base. The stability of the structure was necessarily of paramount importance. There are eight stories, one of which contains the fog signal. The various dimensions are shown in the drawing. It will be noticed that a similar arrangement of the staircase is used here as in the light-house of Heaux de Bréhat.

The work was conceived and planned by M. Léonce Reynaud, director of the light-house service. It was carried on under the greatest of difficulties, and too much praise cannot be given to the brave sailors and Breton workmen who insured the success of an enterprise bolder and more rash than any preceding undertaking of a similar nature.

LIGHT-HOUSE AT HAUT BANC DU NORD.

Another method for constructing a foundation under water was successfully practised during the building of the light-house at Haut Banc du Nord. This is a limestone plateau about two miles off the northeastern extremity of the Isle of Ré. It is nearly horizontal and about fifteen hundred feet long by five hundred broad. It is cut up by numerous channels of various depths, and is only uncovered at low spring tides, when the wind happens at the same time to be off shore. The rocky shoals surrounding it permit only crafts of small tonnage to approach, and at low tide the winding channels render this approach difficult even for the smallest boats. It was therefore necessary to anchor the transports at some distance from the rock, and to convey the material to it in barges — a difficult and risky business, even in a moderately rough sea.

To establish the foundation there was first constructed a large iron bottomless caisson, in the form of a twelve-sided prism, which was suitably braced on the inside. "It was nearly forty-seven feet in diameter, four feet high, and weighed about five tons. Sustained by means of floats, it was towed into place at high tide by a small steamer and then grounded on the rock. After the tide had fallen sufficiently, and while it was not too rough, a movable flooring was placed on the upper frame of the interior bracing, and on it the workmen made the concrete for filling the caisson.

The lower part of the foundation was made of concrete poured through copper tubes one foot in diameter, and funnel-shaped at top. As soon as the water had fallen sufficiently to uncover the concrete, the remainder of the foundation was built of rubble masonry, which could be laid much more rapidly. The solid masonry then built was protected by a band of cut stone, which was placed after the tower was completed.

This work was commenced in 1849 and completed in 1853. The cut-stone protection, however, was not placed until some years later. Its cost was about $66,000.

It is a third-order light-house. The base is a solid mass of masonry. Above are the rooms communicating with each other and with the lantern by means of a series of small stairs. The size of the tower did not admit of a separate staircase, as in the preceding instances.

As reference has been made in the preceding pages to lights of various orders, it is proper to state, for the benefit of the lay reader, that light-houses are divided into various orders, from the first to the sixth, according to the lens apparatus for which they are designed; the first order being the most powerful and also necessitating the highest towers, so that the curvature of the earth will not cut off the light too soon; these are placed on outlying capes, rocks and headlands, to give warning of approach to the coast line. The range assigned to first-order lights varies from eighteen to twenty-seven nautical miles, according to their character.

Second and third order lights are employed to mark the secondary capes, islands, rocks, reefs and sand-bars embraced between the more prominent headlands, while lights of inferior order designate the entrances to harbors and channels, and vary in intensity according to the distance at which they should be seen. These are general principles, but geographical reasons prevent them from being applied rigorously.

[To be continued.]

Adamite Fashions according to the Glass-stainers. — A plain Puritan of Boston, who has been travelling in frivolous Europe, has this to say about a solemn subject: "I was amused with some very old stained-glass windows which admit a 'dim, religious light,' at the Milan Cathedral, and are supposed to illustrate scenes in the Old Testament. It may not have been reverential, but I had to laugh to see Cain in a pair of green pantaloons, killing Abel, who was dressed in a short jacket of yellow stuff. I regretted to see that Eve, when driven out of Eden by the archangel with the flaming sword, was so frivolous as to array herself for the occasion in a purple overskirt, cut very decollette, while Adam wore a blue hat and pink ribbons. There may be authority for these representations — I do not know — but they were a surprise to me." — *Exchange.*

The Illustrations

[Contributors are requested to send with their drawings full and adequate descriptions of the buildings, including a statement of cost.]

THE ROTCH TRAVELLING-SCHOLARSHIP DRAWINGS. — PLATES XXXVII, XXXVIII, XXXIX.

[Issued only with the Imperial edition.]

SECOND PERMIATED DESIGN FOR THE CATHOLIC UNIVERSITY BUILDING, WASHINGTON, D. C. MR. O. VON NERTA, ARCHITECT, WASHINGTON, D. C.

THE instructions required a plain, substantial brick building with stone trimmings, of sufficient size to accommodate eighty students, eight professors and rector, with all necessary adjuncts as lecture-halls, refectory, chapel, etc. The cost was limited to $175,000. Perspectives were excluded. The building site is a beautiful tract of land of forty acres about two miles outside the city and opposite the Soldiers' Home.

LIGHT-HOUSES AT AR-MEN AND HEAUX DE BRÉHAT, FRANCE.

For description see article on "Ancient and Modern Light-houses" elsewhere in this issue.

OFFICES OF THE MUTUAL LIFE INSURANCE COMPANY OF NEW YORK. MR. C. W. CLINTON, ARCHITECT, NEW YORK, N. Y.

CAPE COD SKETCHES. — NO. II.

THE TREATMENT OF SEWAGE.[1] — X.

I. — AMOUNT OF SLUDGE.

THE quantity of sludge varies enormously, according to the amount of sewage and the precipitants employed. Thus, at Coventry the sludge from 1,000,000 gallons is about 12.5 tons, whereas at Birmingham it varies from 25 to 33 tons.

The quantity of sludge produced from a given quantity of sewage will vary according to local circumstances and conditions; such, for instance, as the character of the soil, the condition of the streets and roads, whether surface-water be wholly or in part admitted to or excluded from the sewers, whether manufacturing refuse is included in the sewage to be treated, whether or no the water-closet be in general use, and whether the process of precipitation be complete and efficient or only partial.

In a town where water-closets are in general use, where the soil is of gravel and sand, where surface water is partially admitted into the sewers, where there are no manufactories, and where precipitation is well and efficiently done with chemicals of moderate bulk, the proportion of pressed sludge containing 50 per cent of moisture, may be taken at six-tenths of a pound per head per day, or about 2 tons 14 cwt. daily per 10,000 of the population.

The principle is right: Consistent with efficiency, produce as little sludge as practicable, and this for two reasons: (1) that if it has any value, you secure its maximum value; whilst (2) if it has no value,

[1] A paper by Dr. C. Meymott Tidy, read before the Society of Arts, April 14, 1886, and published in the *Journal* of the Society. Continued from No. 577, page 33.

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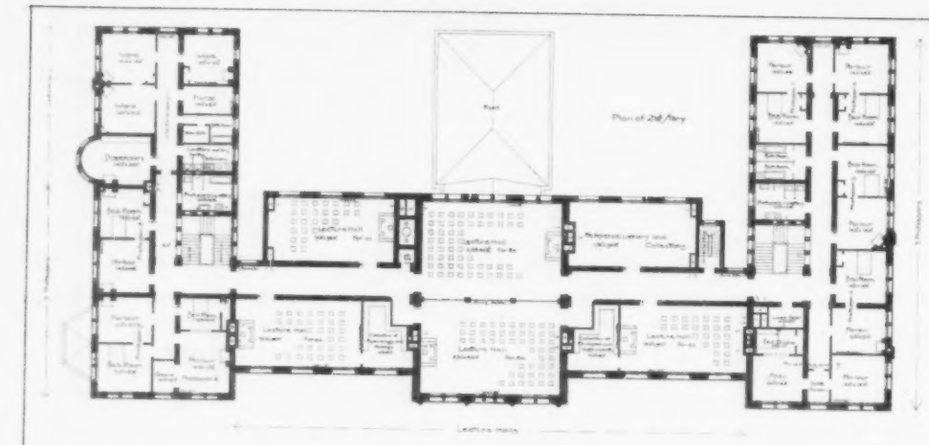

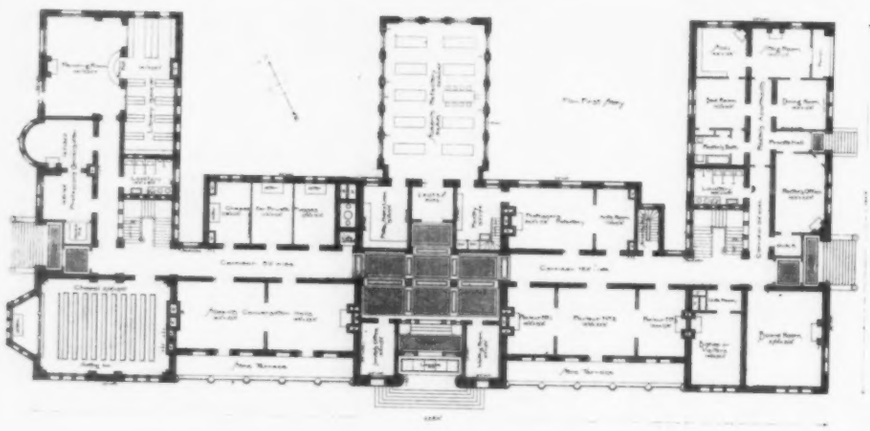

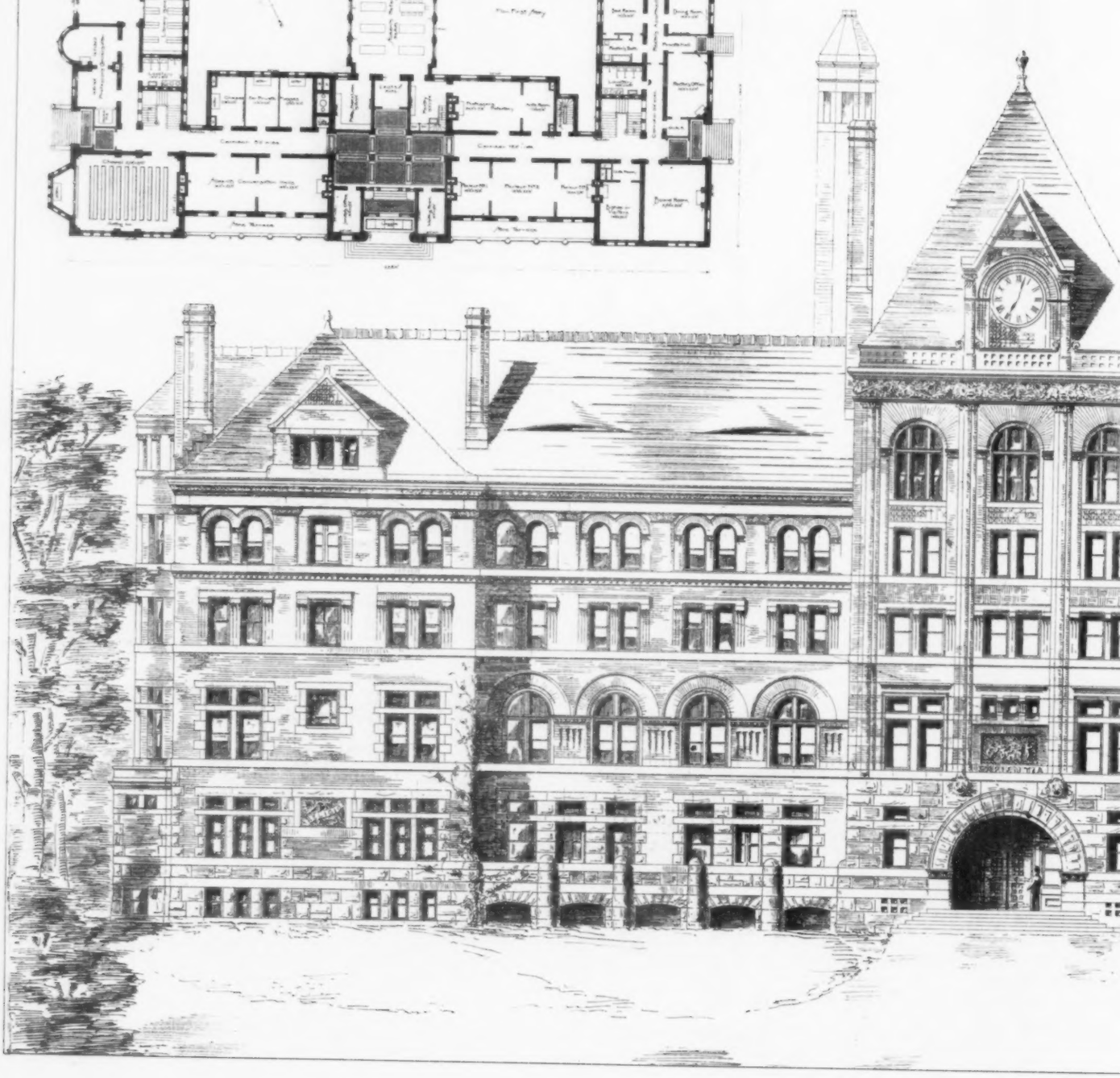

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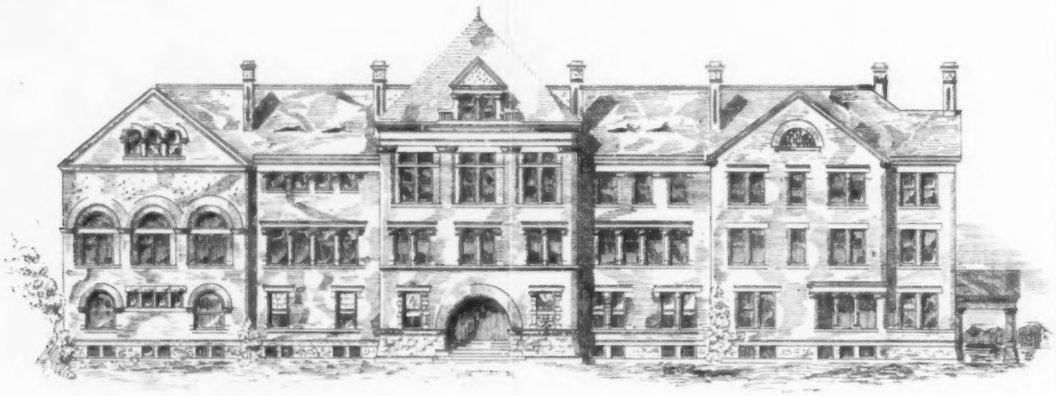


Alternative Design for

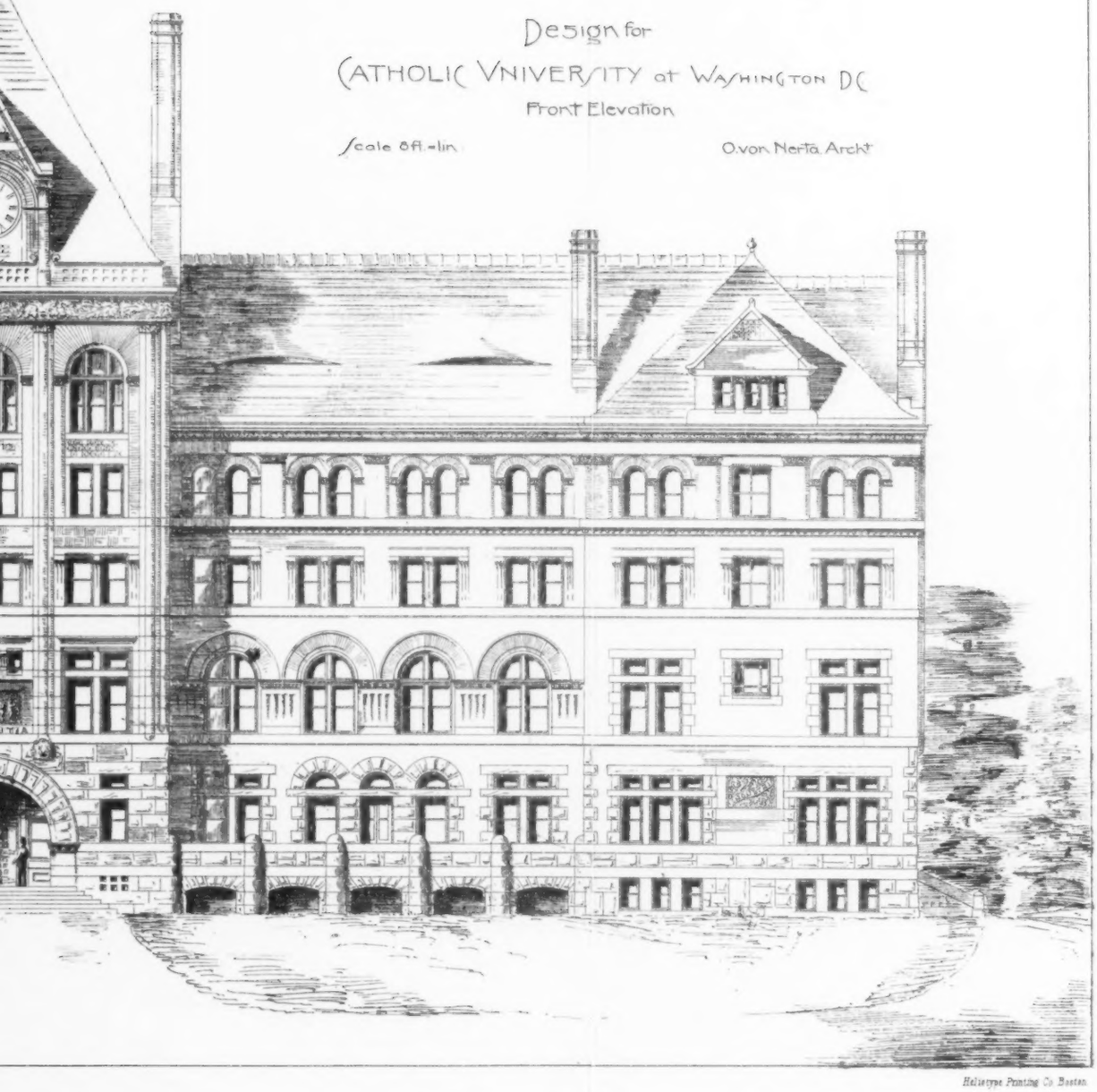
Design for

CATHOLIC VNIVERSITY at WASHINGTON DC

Front Elevation

Scale 8 ft. = 1 in.

O. von Nerta. Archt



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No. 578 American Architect and Building News, Jan. 22 1887.

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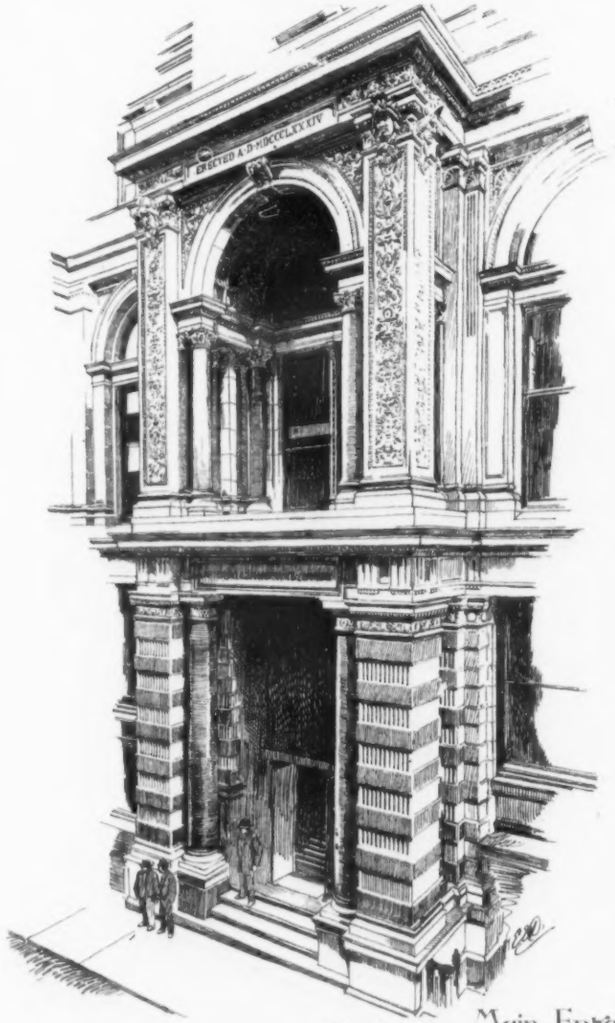
Building for the Mutual Life Ins. Co. of New York. on Nassau St. N.Y.

C. W. Clinton, Arch't.

In Board of Trustees Room. from Photograph



from Photograph. Main Entrance.

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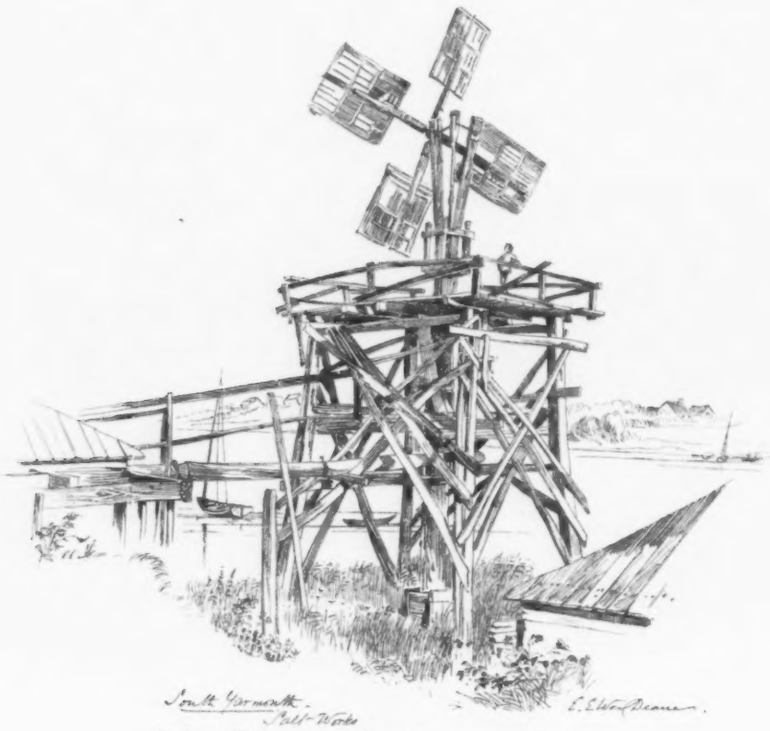
Cape Cod Sketches. No. 2.



South Yarmouth. Salt Works

These windmills pump the water into series of tanks for solar evaporation and precipitation of the salt

E. Elliot Beaman.

One of the shores of Provincetown

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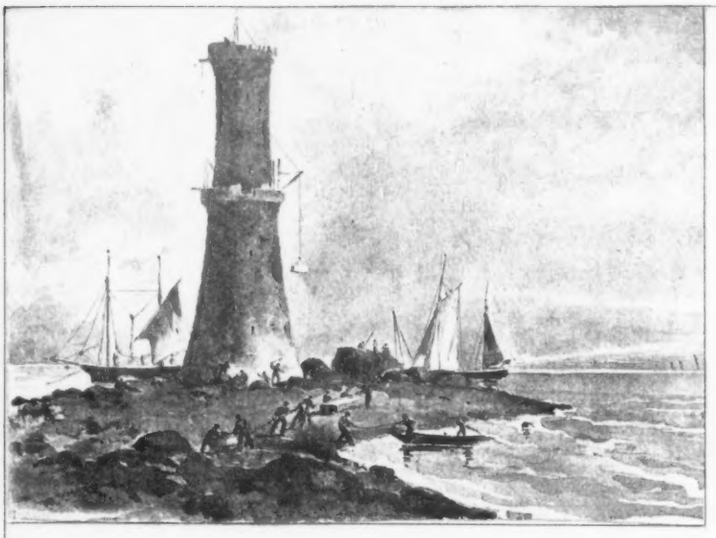
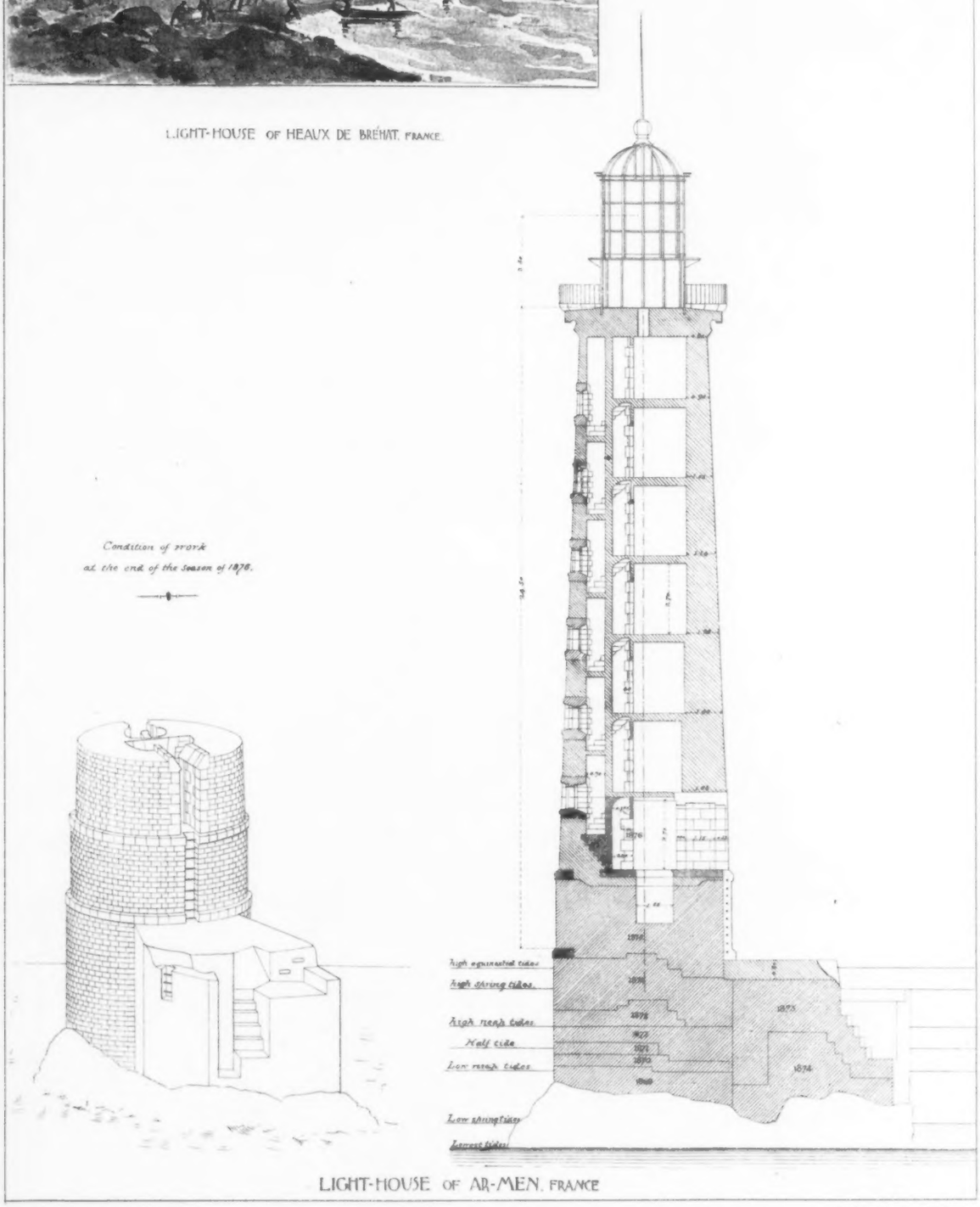


LIGHT-HOUSE OF HEAUX DE BRÉHAT, FRANCE.



LIGHT-HOUSE OF AR-MEN, FRANCE

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American Architect and Building News, Jan. 22 1887. No. 575

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Building for the Mutual Life Ins. Co. of New York.
on Nassau St. N.Y.

C.W. Clinton, Archt.

Detail. from photo.

Heliotype Printing Co. Boston.

you have the less to get rid of. Thus with some precipitants you get a large volume of valueless sludge. With sulphate of alumina you get comparatively little sludge, but a material of greater value. Of course it may be argued that the more sludge you obtain, the more perfect has been the removal of the impurities of the sewage. This may or may not be true.

II. — COMPOSITION AND VALUE OF SLUDGE.

I am anxious at once to say that I place no intrinsic value on the sludge whatsoever. An estimate of the value of sludge from different places has been given on high authority, but it is better to regard the sludge as a thing to be got rid of, and as a thing which, to be got rid of, must cost money and may not bring money. In the following Table the analyses of sludge from various places, and by various methods of precipitation, have been given by Dr. Wallace as follows:

ANALYSES OF SEWAGE SLUDGE (AIR-DRIED).

Name of Town.	Aylesbury.	Birmingham.		Bolton.	Bradford.		Coventry.		Leeds.			Leicester.	Windsor.
Process of Precipitation.	A B C	Lime. 1	Lime. 2	Lime and charcoal.	Lime.		Sulphate of alumina.		Modified A B C	Hanson's process.		Lime.	Hille's process,
Date.	1879	1879	1879	1879	1876	1879	1877	1879	1876	1876	1877	1879	1877
Water	12.60	12.70	13.16	14.34	8.90	6.92	14.04	10.04	9.56	16.40	11.76	11.93	11.76
Organic matter, carbon, etc.	35.60	19.19	20.04	26.18	33.75	34.53	20.58	23.09	20.82	27.92	12.06	22.18	12.06
Boracic acid	2.11	.40	.72	.62	.80	.73	1.56	2.07	.75	1.21	.87	1.21	.87
Phosphoric acid	2.70	1.45	.35	.61	.64	1.74	1.32	.56	2.15	1.02	.49	.51	.49
Sulphuric acid	2.18	1.62	8.53	8.30	10.53	13.77	6.64	5.71	8.42	13.11	22.71	15.25	22.71
Limonic acid	11.19	12.74	14.60	16.90	20.47	5.07	9.16	6.05	9.08	17.51	31.69	20.16	31.69
Magnesia	.38	.37	1.08	1.66	2.11	2.01	.86	.61	5.64	7.67	1.48	1.48	1.48
Oxide of iron	6.30	2.70	3.30	1.08	2.11	4.14	2.06	4.14	4.61	2.32	1.68	2.66	1.68
Alumina	6.75	2.68	2.58	1.07	3.49	4.13	5.80	4.33	7.04	6.39	2.31	1.63	2.31
Sand, etc.	33.60	37.93	37.93	29.60	21.30	10.23	37.83	42.60	31.60	7.36	14.16	22.30	14.16
	101.22	99.96	100.62	100.06	100.58	99.16	100.26	99.16	100.16	100.36	98.71	99.31	98.71
Phosphate of lime	4.61	.87	1.57	1.35	1.74	1.59	3.40	4.52	1.39	1.64	1.90	2.64	1.90
Nitrogen	1.60	.52	.49	.61	.62	.66	.92	1.37	.66	.70	.52	1.08	.52
Equal to ammonia	1.94	.63	.60	.74	.76	.80	1.11	1.55	.80	.84	.63	1.31	.63
Calculated value per ton.	s.	s. d.	s. d.	s. d.	s. d.	s. d.	s.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
	33	10 9	11 5	13 4	15 1	15 4	20	27 2	14 2	17 2	11 5	21 7	11 5

A table by Dr. Voelcker on the estimated and market values of one ton of sludge from places stated is given below.

ESTIMATED AND MARKET VALUES OF ONE TON OF SLUDGE FROM PLACES STATED (VOELCKER).

	Estimated or theoretical value.[1]			Practical or market value.[2]			
	£	s.	d.	s.	d.		s. d.
1. Bolton sludge (M and C process)	0	9	8½	3	3	to	4 10
2. Bolton sludge, 15 per cent of moisture	1	1	1	7	0	to	10 6
3. Bradford sludge before lime was added	0	11	0½	3	8	to	5 6
4. Bradford sludge with 15 per cent of moisture	0	19	3	6	5	to	9 6
5. Bradford sludge after treatment with lime	0	4	8	1	6	to	2 4
6. Bradford sludge with 15 per cent of moisture	1	0	0½	6	8	to	10 0
7. Aylesbury, A B C sludge	0	8	4½	2	9	to	4 2
8. Aylesbury, A B C sludge with 15 per cent of moisture	0	16	8½	5	6	to	8 4
9. Coventry sludge of General Sewage Manure Co.	0	16	9½	5	6	to	8 4
10. Rochdale manure	0	15	11½	5	4	to	8 0
11. Halifax manure by Goux's process	0	17	7	5	10	to	8 9

The old system consisted in merely placing the sludge in pits, and allowing it to air-dry. In this condition it was sold or given to the farmers. I may mention here that a sludge containing 90 per cent of moisture can be reduced to 80 per cent by forty-eight hours' draining, to 75 per cent by three days' draining, and to 71 per cent after a week's draining. After this, air drying is comparatively slow, although no doubt the admixture of porous substances would render drying more rapid and more complete.

[1] Calculated on the supposition that phosphate of lime is worth 1*d.* per pound; potash 2*d.*, and nitrogen (as ammonia) at 8*d.*

[2] By this is implied its value as compared with good farm-yard manure, which has a theoretical value of 15*s.* 7*d.*, its market value being from 5*s.* to 7*s.* 6*d.* per ton.

III. — DISPOSAL OF THE SLUDGE.

1. *Johnson's Process.* — By this process the liquid portion of the sludge is extracted by pressure in a series of compartments. Each compartment is provided with a canvas cloth, which acts as a strainer, and retains the solids as the liquid passes through. The sludge is driven into the compartments by compressed air, 100 to 120 lbs. per square inch, until they can hold no more. On opening the press, a solid cake of compressed sludge is found in each compartment. The cake is compact, easily handled, and practically has no smell. It has a certain manurial value.

It is worth while to consider a few details of pressing. The sludge, as precipitated, contains on an average 90 per cent of water, whilst the pressed sludge cake contains 50 per cent. By simple air drying, the 50 per cent of moisture may be reduced to less than 20 per cent. Thus, in every ton (2,240 lbs.) of unpressed sludge, 2,016 lbs. is moisture, and 224 lbs. solid matter. After pressure, the 224 lbs. of solid matter holds about 224 lbs. of moisture, the removal of 1,792 lbs., or about 179 gallons of water having been effected. The time occupied in the compression of 5 tons is about one hour. The sludge cake, according to Monro, contains from 0.6 to 0.9 per cent of nitrogen, and over 1 per cent of phosphoric acid. It has been the practice to run back the liquid expressed from the sludge into the sewer, to be re-treated. Professor Dewar and myself have pointed out that this course is unadvisable. The liquid thus expressed is exceedingly foul, although perfectly clear, and does not readily lend itself to ordinary chemical precipitation. I will merely note that it requires separate treatment, and that our experiments indicate chloride of lime or perchloride of iron in larger amount than is required for ordinary sewage may be rendered effective for the purpose.

The manurial value of the pressed sludge cake from Coventry, Leyton, and West Ham, has been the subject of careful investigation by Dr. Monro, from whom I have abstracted the percentage details of experiments on the dried sludge given in the next table.

The phosphoric acid in sewer sludge is chiefly in combination with alumina. Dr. Monro notes that whilst Coventry sewage contains much manufacturing refuse from dye-works, and West Ham sewage the refuse from industries of a most varied and polluting character, Leyton is a rural and suburban district, having no manufactures of any kind contributing to the sewage.

PERCENTAGE DETAILS OF EXPERIMENTS ON THE DRIED SLUDGE.

	Coventry sludge dried. Precipitants, lime and sulphates of alumina and iron (filtration).	Leyton sludge dried. (Precipitants like Coventry.)	West Ham — sludge dried. (Precipitants, sulphate of alumina and lime.)
Organic matter	26.14	26.08	40.32
Containing nitrogen	1.36	1.35	1.82
Potash	0.30	0.34	0.22
Total P_2O_5	2.43	2.04	2.57
Soluble P_2O_5	1.37	1.69	1.24

Dr. Monro has practically tested the agricultural value of these pressed sludge cakes, for the details of which the reader is referred to his original paper. Good crops of swedes were obtained. The three sludges gave almost identical results as regards yield. The following were the results obtained by him with different dressings for comparison:

RESULTS PER ACRE.

	Tons.	Cwt.
1. 10 tons farm-yard manure	13	11½
2. 4 cwt. superphosphate	11	2½
3. 5 tons Leyton sludge	10	4
4. 5 tons farm-yard manure	10	1½
5. 5 tons West Ham sludge	9	8½
6. 5 tons Coventry sludge	9	6½
7. 2 cwt. superphosphate with 2 cwt. of nitrate	9	5½
8. 2 cwt. superphosphate	9	4½
9. 2 cwt. coprolite	8	15½
10. 4 cwt. coprolite	7	10
11. Unmanured	5	18

From the details it is evident that the air-dried filter-pressed cake has a certain manurial value — at any rate, about equal to farmyard manure, — which possibly, considering how easily it may be stored without causing a nuisance, may be worthy of being considered more fully than it has at present. It is worth noting that, although the newly-pressed cake is richer in nitrogen than farmyard manure, and contains more than double the amount of phosphoric acid, still that the manurial value is not greater, weight for weight. This Dr. Monro explains by differences of physical condition, viz., the loose texture of farmyard manure compared with the compact condition of the sludge-cake; the physical state of the one being as favorable to rapid oxidation and disintegration as that of the other is unfavorable. To overcome this difficulty, Dr. Monro suggests the reduction of the cake to a fine state of subdivision.

The cost of procuring the sludge is stated by Mr. Hutchinson (to

whose excellent paper I must refer) as from 2*s.* to 2*s.* 6*d.* per ton at Coventry. I have no records as to what the further cost of grinding would involve.

The Johnson process is at work at Croydon Rural, High Wycomb, Coventry, Leyton, Blackburn, and Aylesbury.

2. *Major-General Scott's Process.* — This is adopted at Burnley. The lime-precipitated sludge (*i. e.*, lime and organic matter) is drained until it contains about 65 per cent of moisture. The sludge at this stage is tested as to the amount of lime present, more being added if necessary. The mass is now dried by heat, and finally burnt in kilns. The residual clinker is ground, and used as an hydraulic cement (Portland cement). The cement is said to have a tensile strength of 350 lbs. per square inch after immersion in water for seven days, and to be worth 35*s.* per ton.

It is evident that the composition of sewage sludge varies not only in different towns, but in the same town at different times. It is not quite clear how far this process can be worked so as to secure that which engineers know to be so important, viz., a cement of constant character. (See paper by Granville Cole, Ph.D., Society of Arts Conference, 1879, p. 137.)

The cost of drying is 7*s.* per ton. The coke employed for burning averages 1*s.* 4*d.* per ton, and the labor, etc., 15*s.* per ton.

Major Scott has suggested that in the case of the London sewage both a manure and a cement might be prepared.

In the *Journal of the Society of Arts*, November 28, 1879, he suggests, in the treatment of the sewage, that the primary separation of the coarser mineral suspended matter should be effected in a first tank, a sufficient period of rest being afterwards allowed for the subsidence (not the artificial precipitation) of the lighter suspended matters in a second tank. The sludge of this second tank (*i. e.*, after the watery portion has been drawn off) is to be treated with about two-thirds its weight of milk of lime, sufficient superphosphate being afterwards added nearly to neutralize the lime. (The superphosphate is to be prepared by mixing 20 cwt. of Cambridge coprolites with 17 cwt. of brown sulphuric acid, sufficient water being added to render the mixture almost fluid). By this treatment the mixture (he states) becomes surprisingly inodorous, and dries with rapidity. The cost of chemicals he values at 16*s.* 6*d.* per ton of prepared manure, its removal from the tanks and subsequent drying being 3*s.* 6*d.* He considers it worth £3 10*s.* per ton of prepared manure. The sewage, or liquid portion of the second tank, from which the organic matter has been recovered, is then to be treated with lime, and the precipitate thus obtained made into a cement.

Major Scott seems to have overlooked the difficulty of effecting precipitation of the suspended matters of sewage (such as he is desirous of obtaining in the second tank) without the use of precipitants. Further, a limed sludge, when dried, is certain to lose ammonia, in other words, is certain to lose manurial value.

The deposit in the first tank, Major Scott proposed, should be burnt in a destructor with waste cinders, and be used to reclaim a portion of the marshes. At any rate (he justly considers) it ought not to be allowed to pass into the river.

3. *Destructor.* — The destructor has been carried to its greatest state of perfection at Ealing, under the ingenious and careful management of Mr. Charles Jones. In this case, however, the ashes of the district are mixed with the sludge. The chemicals used for precipitation are 11.5 grains of clay and about ten grains of lime per gallon, a little iron and alumina being also used. The sewage treated comes from a population of about 18,000, and is equal to 600,000 gallons daily. About 157 cubic yards of sludge are obtained per week. This is mixed with about 100 cubic yards of ashes and house refuse. Before the mass is burnt in the destructor, about 25 per cent of the liquid portion is allowed to drain away.

It may be advisable here to note the difficulties that have been met with generally in the use of destructors:

1. An escape of vapors that prove more or less offensive at a considerable distance from the shaft. This depends on the materials having undergone incomplete burning, in other words, that the materials in the destructor have been subjected to destructive distillation (in which case the products, consisting of various empyreumatic vapors are offensive) rather than combustion, in which case the products would be simply water and carbonic acid, and inoffensive. No doubt, until lately, the escape of unburnt and partially burnt vapors, a very small quantity of which sufficed to cause a nuisance, have proved a serious objection to the use of destructors.

2. The escape from the shaft of unburnt or partially-charred paper, fine sand, etc., at certain stages of the process.

I do not hesitate to say that both of these difficulties are met in Jones's destructor. This has been done by mixing the sludge with the house ashes, thus assisting effective combustion. Mr. Jones lays down that every town supplies sufficient house refuse to burn its sludge. The main point, however, on which he relies, is the construction of a muffle furnace (a fume destroyer, as he calls it) between the furnace and the main shaft. As a result, not only is a greatly-increased draught secured, but the combustion of unburnt vapors discharged from the furnace in which the sludge is placed is secured. I may add that Mr. Jones informs me that the muffle furnace is kept going at a cost of 1*s.* 6*d.* per day, but that this, in addition, gives 10 lbs. of steam for engine purposes. He obtains, as a residuum from the furnace, 25 per cent of hard clinker, which is utilized in various ways, viz., for artificial stone, road-making, etc.

Various suggestions for what may be called fortifying the sludge have been suggested. Thus, Colonel Jones, of Wrexham, after drying the sludge to 20 per cent of moisture, adds to every 12 parts 7 parts of raw bone-meal and 1 part of sulphate of ammonia.

I do not propose discussing other suggestions for the disposal of sludge, such as the separation of the water by centrifugal machines — converting the sludge into a fuel by admixture with other waste products — its conversion into a combustible gas — making it into bricks, etc. (Monson). These suggestions are scarcely practical.

The question of cost must be considered in conjunction with (1) the quantity of the sewage, (2) the quality of the sewage (that is, the nature of the sewage other than mere excreta), (3) the flow per head, and (4) the standard of excellence required.

As regards quantity, I wish to say that you cannot apply the cost of treating small volumes of sewage to the cost of treating large volumes, the treatment of the former being more easily effected than the latter.

PRICES OF CHEMICALS.

Green copperas or proto-sulphate of iron can be obtained for about 20*s.* per ton.

Lime can be obtained from 10*s.* to 15*s.* per ton.

Sulphate of alumina can be obtained for 46*s.* 6*d.* per ton, as per following analysis:

Moisture	5.94
Crystalized sulphate of alumina	77.44
" sulphate of iron	4.00
Sulphates of alkalies and sulphuric acid	6.82
Insoluble iron and alumina	5.80
	100.00

The annual cost of thoroughly and efficiently treating the sewage of Coventry, pressing the whole of the sludge, etc., exclusive of interest on plant, land and depreciation — the population contributing being 45,000 persons, and the sewage containing large quantities of dye and manufacturing refuse — is £2,800 per annum, an amount equal to 1*s.* 3*d.* per head.

The cost at Hertford, where the sludge is not pressed, and manufacturing refuse is absent, with a population of 7,747, is £570 per annum, equal to 1*s* 5½*d.* per head.

A few words only on the analysis of sewage. No single analysis of a sewage effluent is satisfactory as proof of good or of inefficient working. Knowing as we do that sewage varies from hour to hour, no accurate conclusion can be drawn as to the composition of the raw sewage or of the effluent, except by collecting half-hourly, or at least hourly, samples during one entire period of twenty-four hours, and the various samples mixed in the proportion of the fluid. The analysis of a sample of raw sewage and of an effluent taken about the same time are not comparable, because the passage of the sewage through the tanks is commonly the work of some hours. Supposing, for example, I collect a sample of twelve o'clock sewage and a sample of effluent at the same time, the twelve o'clock sewage may be the very strongest sewage of the day, whilst the effluent sample is the effluent of the very weakest sewage. Precisely the opposite conditions may occur, viz., that I may compare the effluent of the strongest sewage with the weakest raw sewage delivered.

Further, in all cases where analyses are made for test purposes, the weather should be noted, the rainfall and the flow being compared with the average flow. For accurate purposes a normal condition of flow should be selected, and comparison made between the average of twenty-four hours' sewage and twenty-four hours' effluent.

As regards the analysis of sewage, it is advisable to estimate the quantity of the matters in suspension, and in these the amount of mineral and organic (with volatile) matters. In addition to this, I have of late adopted the system of estimating the organic carbon and nitrogen, and the oxygen required to oxidize the organic matter in the effluent without removing the suspended matter. Seeing that the real issue is the condition of the effluent, I consider this method preferable to an analysis of the clear effluent after the removal of the suspended matter.

I propose the following form as one which conveys the best information that chemistry can afford as to the chemical composition of a sewage and of an effluent:

The results are stated in grains per imperial gallon of 70,000 grains.

Matters in suspension — Total .....
(*a*) Organic and volatile .....
(*b*) Mineral .....

The following details have been obtained from the effluent without the removal of the suspended matters:

Total solids (suspended and dissolved) ....
Ammonia .....
Chlorine .....
= Chloride of sodium .....
Nitrogen (as nitrites and nitrates) .....
Oxygen required to oxidize organic matter
Organic carbon .....
Organic nitrogen .....

To get rid of excretal filth with the least possible delay is no doubt the teaching of sanitary science. The advocates of the water-closet urge that water as a vehicle to carry the refuse commends itself to us on the ground of convenience, cleanliness and cheapness. They

would compare, with plausible argument, the natural power of gravitation (such as is made use of in the water-closet) with an organization of men and carts (such as is required by the dry-earth system). The advantages, at first sight, seem all on one side. Facts, however, point in an opposite direction. Dilution with water is the best known method of rendering practically useless whatever is valuable in sewage — indeed, worse than useless, an ungovernable nuisance. The excreta of animals are no doubt intended for the food of plants, and for our use through their intervention. Of course, do what we will, nature will assert herself and her plans. But nature is embarrassed by our meddlesomeness. The nutritive food of the plant we drown in water, our ingenuity failing when we attempt to deal with the filthy mixture. We cannot utilize it, unless we abandon all sanitary precautions; it pollutes our air, renders our ground a stinking morass, and defiles our water-courses. Thirty gallons of water daily per head is brought to us who live in London, from pure sources, at great cost, and with great engineering skill; filtered, often refiltered, with extraordinary care; stored with scrupulous anxiety; analysed by one chemist after another. It is, however, a striking fact that only one-nintieth part of the entire water-supply is used for drinking purposes, a large quantity being destined to become the diluent of our sewage, to perplex us by its quantity, to bother us by its uselessness, and to steal our health by the perpetual nuisance it occasions.

I desire to acknowledge my indebtedness in the preparation of this paper to numerous friends. Amongst others I cannot forbear mentioning Professor Dewar, Mr. Hawksley, Mr. Mansergh, and Mr. Melliss.

[The end.]

FIRE AND LIFE RISKS IN ELECTRIC LIGHTING AND TRANSMISSION OF POWER.[1]

AT the regular meeting of the Electric Club held in New York on the evening of November 4, Dr. Geo. H. Benjamin, a member of the executive committee, read a paper on the above-named subject. At its conclusion a Colonel Morrison, the representative of an electrical company, pronounced the statements contained in the paper exaggerated and untruthful, whereupon considerable excitement in the club ensued. This prevented the consideration by the club of the rules submitted by Dr. Benjamin. We present herewith the full text of the paper, with the rules submitted by Dr. Benjamin:

In 1882, the Board of Fire Underwriters of the City of New York adopted a series of rules relative to the precautions to be observed in the introduction of the electric-light into buildings, and which were published at the time, and with which you are all doubtless familiar.

However well these rules may have been suited to the date of their promulgation, I believe it will be generally admitted that they are unsuited and inadequate to the present needs. With all new industries or the practice of new arts, it has been the rule to allow the utmost latitude and to impose as few restrictions as is possible compatible with public welfare, this with the idea of lending encouragement and facilitating the introduction of such new art or industry; but when after a time the industry or art has become well understood and established on a firm commercial basis, further and supplemental restrictions are generally imposed with the intention of making the employment of such art or industry absolutely safe for all concerned, those engaged in the practice thereof, as well as those using or being benefited thereby.

When the dangers arising from the employment of electric currents of such quantity or electro-motive force, as are required in electric-lighting, were first pointed out through the medium of the public press, there was a great hue and cry raised by those engaged in the business, and unstinted abuse was heaped on the heads of the unfortunates who had dared to have the temerity to advance such radical ideas. Time works wonders, and I doubt not that to-day, even those employed in the business of electric-lighting, see and feel the necessity of precautionary rules, and likewise the advisability of their most rigid enforcement. If any one present sees fit to question my premises as stated, I would respectfully refer them to the disastrous fires and terrible accidents which have been lately recorded in the daily press — fires which caused the destruction of large amounts of valuable property, accidents by which men were unncessarily deprived of life. I say unnecessarily as regards life, as the possibility of such slaughter should be guarded against by absolute prohibition, and if necessary, by statutory enactment, making it a penal offense to direct or employ men, however experienced in that class of electrical work, where the slightest oversight or unavoidable slip means sure and instant death. Some of you may be inclined to argue that employers should not be held responsible for the carelessness and negligence of their men; that the men seek the employment well knowing the terrible dangers to which they will be subjected. To them I say that the root of the matter should be sought. The struggle for existence and the difficulty in obtaining employment at the present time is a most potent factor in causing those in need to seek and obtain situations, however great the risk entailed. If the remedy were directed toward the fountain-head, and the principal or management of the company employing such dangerous currents were held personally responsible, then they would make it their business to see that no unnecessary risks were entailed, and they would in effect become guardians of their men. That familiarity breeds contempt is an old saw, and to warn the average electric-light line man or machine attendant to be careful is sure to provoke a derisive smile. "All right, I'll look out for myself," was the answer of an old and experienced employé in a Western city a few weeks since. In less than two minutes thereafter he was stone dead. Thought the circuit was open. If the president of the company had been fully aware that he would be held responsible for such an accident, he would have seen to it that the circuit was open, and a human life would not have been needlessly sacrificed. Some may argue that there are occasions when it is impossible to open the line without serious loss or public inconvenience, and that repairs may become necessary when the line is in full operation. To those I say that there can no occasion arise in which an employé must necessarily risk his life. What does it matter if one, twenty, fifty or any number of lights be cut out? Nothing compared to a human life, and particularly as I maintain that no condition can arise where the necessity of cutting out any such number of lights is obligatory.

When a man, under our laws, is tried for his life, the law presumes him innocent. There are many cases on record where hundreds of thousands of dollars have been expended to save the lives of men probably not as worthy as either of the two poor fellows lately so wantonly slaughtered. More money, yes twice over, than would have been required to buy out and obliterate the electrical companies owning the plant which caused their death. The good of the many (the public) may at times require the sacrifice of the lives of the few, but the good of an electric-light company is not the good of the public, and it is incomprehensible that a mere commercial concern should be allowed, by gross carelessness or ignorance, to sacrifice the life of even the meanest of human beings. Therefore, I contend that stringent and prohibitory means should be adopted to make such accidents in the future an impossibility, and further, that such rules should have the cordial support of every one having the true interest of electric-lighting or the transmission of power at heart. So far as the risks from fire are concerned, it is not necessary to enumerate them. Unfortunately, sad experience has made them only too well understood. Careless, stupid, and one may say criminally loose methods of wiring, have been the rule rather than the exception in this country. Of course, with some notable exceptions, and all those who have carefully studied the subject, and are conversant with the needs, feel that the enforcement of proper and stringent rules will not only allay public fears and restore confidence, but like wise materially benefit the industry.

I contend, gentlemen, that we should look upon this subject in a broad light, and free from the narrow prejudice of business. We should recognize the necessity and not attempt to evade the responsibility. To make an electric-plant perfectly safe may necessitate slightly increased cost of construction — although personally, I am inclined to doubt the fact. But even admitting such to be the case, the perfect immunity from danger, the increased cost of insurance, and the general confidence engendered in the public mind, will be a good interest upon such additional outlay.

The rules which I would submit to your consideration are as follows, and have been written after a careful examination of the rules of all the fire-boards and underwriters' associations of the world. I have endeavored to make them as concise and clear as possible, and with the intention of providing as few onerous conditions as are compatible with absolute safety to life and property. Such rules are comprehended under the headings: (1) Rules to be observed in conveying currents of considerable quantity or electro-motive force in and through buildings. (2) Rules to be observed in locating and constructing ærial and underground conductors. (3) Rules to be observed to prevent accidents to life or bodily injury.

I. — RULES TO BE OBSERVED IN CONVEYING CURRENTS OF CONSIDERABLE QUANTITY OR ELECTRO-MOTIVE FORCE IN AND THROUGH BUILDINGS.

1. The degree of E. M. F. that may be employed in an electric circuit within any building should not exceed one hundred volts for alternating currents, or two hundred volts for continuous currents. No departure will be allowed from this rule except by special permit, and then only for arc installations in large buildings where the whole plant is absolutely removed from public interference.

2. The conductivity of all wires should be such that one hundred per cent more current can be transmitted through them than that estimated as their proper carrying capacity, without increasing their temperature above 150° Fahrenheit.

3. No naked conductors allowed in buildings.

[1] A paper read before the Electric Club, November 4, by Dr. Geo. H. Benjamin.

4. All light and power circuits must be entirely metallic, and of properly insulated wire. The employment of gas, water or steam-pipes, or the earth as a part of circuit, is positively prohibited.

5. All conductors should be thoroughly well insulated with a material or materials as non-inflammable as possible, and which will not fray or become loose, melt at a low temperature (below 150° Fahrenheit) or absorb moisture.

6. All conductors that are exposed to moisture, must be provided with a waterproof insulated covering.

7. Where practicable, all conductors in factory or similar buildings shall be so placed as to be readily inspected and tested.

8. No conductor, whether bare or insulated, shall be laid in wet cement, plaster, mortar, or other similar material.

9. All conductors carried through or within walls, floors or partitions, must be inclosed in separate metal, earthen-ware, terra-cotta or asbestos-board tubes, or their equivalent, and which should be slightly larger in their inside diameter than the conductors they are designed to carry. Conductors should not be placed above each other in such a manner that water could make a cross section. Especial care should be taken to protect all concealed wires from mechanical injury.

10. Conductors conveying currents of considerable E. M. F. or quantity as for arc-lights, power, charging of storage-batteries and the like, excluding secondary distribution, should be placed at least six inches apart, the same distance from conducting bodies, and at least two feet from other wires of smaller diameter placed parallel therewith.

11. Conductors conveying alternating primary currents of high E. M. F. must be kept a minimum distance of twelve inches from each other and inclosed in separate highly-insulating fireproof casings.

12. Conductors conveying currents for incandescent-lighting, and having a less E. M. F. than two hundred volts, and running along walls or other exposed supports, should be placed at least two-and-one-half inches apart and a similar distance from all other wires or metallic bodies, except as provided in Rule 9.

13. Conductors for arc or incandescent lighting currents should be placed in grooved mouldings, or casings of wood or dry plaster or like material, preferably arranged along the cornice line, and in such case there should be a septum of the wood or material, having a thickness of three inches for arc currents and one-half of an inch for incandescent currents between the wires. Wooden mouldings may be rendered fireproof by painting them with a solution of tungstate of sodium in water.

14. Single or twin wire insulated conductors may be carried through electroliers or gas-fixtures, but especial care must be taken to insulate such conductors from the metal parts of the fixtures.

15. The location of all concealed conductors should be plainly designated by an appropriate mark.

16. No metallic staples, nails, hooks or devices for attaching and supporting electrical conductors should be employed in buildings. Wooden cleats or porcelain saddles must be provided. Two conductors conveying high potential currents should never be included in the same saddle or cleat.

17. Twin insulated wires may be employed in branches feeding single incandescent lamps in parallel of the main circuit.

18. All joints should be mechanically and electrically perfect; the ends cleaned, united by solder (resin flux employed) and wrapped with insulated tape.

19. Safety fuses should be provided at both points of junction of a branch circuit with a main circuit, and the conductivity of such fuses should in no instance exceed fifty per cent of the current designed to operate the devices in circuit.

20. Where practicable, all safety fuses for each room should be placed in a conveniently located fireproof box, so that they can be inspected or renewed without inconvenience or injury to the premises.

21. A cut-out switch which can be operated by the firemen or police must be placed in the circuit in a well-protected and accessible place.

22. Magnetic cut-outs or circuit-breakers should be used in preference to fusible strips on arc or power circuits, and should be adapted to be thrown into action by any increase of current amounting to fifty per cent or less, as specially required.

23. Magnetic cut-outs, for use in secondary distribution circuits should have double poles and be arranged to act at twenty-five per cent above the normal current, and be placed as near the entrance of the primary conductors into the building as possible.

24. Where incandescent-lights are run on arc-light circuits, fastening or attaching lamps to any gas or other metallic fixture which may be in electrical connection with the earth is prohibited.

25. Distributor boxes from arc-light circuits must be convenient for access-kept free from moisture and dust, and as far removed as is possible from other electrical devices, pipes, metal, etc., or earth connections.

26. Distributor boxes must not be placed in any circuit wherein the E. M. F. of the current transmitted exceeds one thousand volts.

27. Distributor boxes must be arranged to automatically cut out the arc current, should any defect arise or accident occur either in box or incandescent circuit.

28. In working distributors, an ampere-metre should be included in the circuit and connected with an audible alarm, so that warning will be immediately given should the current exceed the standard amount.

29. All switches, cut-outs, safety-fuses, resistance-boxes, distributors, regulators and the like, must always be mounted on a non-combustible insulating base, their contact surfaces kept bright and movable parts examined at least once a day.

30. All switches must be quick in action, and arranged to simultaneously make or break at both poles — connections and rubbing contacts are to be preferred.

31. Arc-lamps should never be employed in factories where there is fine dust, as from flour, pulverized cork or similar substances floating in the atmosphere.

32. The frames and other exposed parts of arc-lamps should be properly insulated from the circuit. Each lamp must be provided with a proper hand-switch; and wherever it is possible that an excessive current may be thrown on to any one lamp or series of lamps, automatic shunts or switches must be provided for each lamp to prevent all possibility of the forming of a dangerous arc.

33. Arc-lamps should be provided with means to prevent the carbons from falling out should the clamps fail to hold them.

34. Arc-lamps must have globes closed at the bottom; and wherever they are placed in proximity to any combustible material, like draperies, goods in show-windows, flyings in fabric factories, or in wood-working establishments, they must be provided with very high globes or spark arresters, and the globes be surrounded by wire netting, to prevent the falling of a broken globe. Broken globes must be replaced at once.

35. Incandescent-lamps should in all cases be mounted in sockets which effectually conceal the terminal connections. Safety plugs will not be allowed in lamp-holders.

36. No dynamo or other source of electricity or motor shall be placed in any room of any cotton, woollen, flax, jute or flour mill or similar mill of like description, excepting in the engine-room thereof; and where it is necessary to locate a dynamo or other source of electrical energy or motor in a dangerous position, such generators or motor must in all cases be housed, and special permission must in all such cases first be obtained.

37. Dynamos, generators and motors in all cases should be placed on dry foundation, and preferably raised from the floor by means of insulating skids. They should be kept free from accumulations of oil and dust. A main switch should be placed at or near the dynamo or motor.

38. Dynamo electric-machines should in all cases be provided with an automatic governing device capable of controlling any change in the current.

39. Storage-cells should in all cases be arranged with a space of one-inch between the cells, on insulating supports and in a dry place, a metal tank or tank lined with metal placed under them to catch any leakage. They should be kept free from moisture and dust, and preferably should be enclosed in a box provided with holes for the escape of gas.

40. Fusible safety strips should be located in the leads conveying the charging-current to the storage battery, and in circuit from storage-battery to translating devices. Switches should likewise be placed in both circuits. Magnetic cut-outs may be employed in place of fusible strips.

41. All circuits shall be tested at least twice a day with some approved apparatus designed for that purpose, in order to discover any ground connection or escape that may exist. A record of these tests shall be entered in a book provided for this purpose, and a transcript therefore furnished to the proper authorities once a week.

42. Where secondary generators or transformers are employed, they should preferably be located exterior to the building in a specially-prepared fireproof structure, which should be perfectly dry. Where necessity requires that they be within the building, they should be housed in a dry wooden room lined with asbestos board — a cut-out should be included in the primary circuit, adapted to act at any increase of twenty-five per cent above normal current. A warning or danger sign should be placed upon door of such housing. When electric-light or power circuits are intended to be constructed, full particulars of the proposed installations and all its details must be given in writing to the proper authorities. This must be accompanied by samples of the conductors with a statement of the maximum current which it is designed to send through each. Samples of the cut-outs, switches and fusible plugs should likewise be submitted unless they have previously been approved. The signing of these rules and regulations by any electric-lighting power or other company transmitting electric currents, shall be considered as a guaranty on their part that they will faithfully observe all the conditions, and make such reports as are therein provided.

II. — Rules to be observed in locating and constructing ærial and underground conductors.

1. Conductors conveying currents having an E. M. F. of over fifty volts, where carried through cities or closely-settled localities, should in all cases be insulated.

2. Conducting wires over buildings must be located at least seven feet above the roofs, and also high enough to avoid the ladders of the fire-department.

3. Conductors conveying currents for arc-light or power, secondary distribution or the like, and when run parallel with telegraph or telephonic conductors, should in no case be nearer than ten feet where single, and six feet where double. By double is meant outgoing and return leads.

4. Conducting wires must be secured to insulating fastenings and covered with an insulation which is water-proof on the outside, and not easily worn by abrasion; and where wires are passed through walls, cornices or the like should be protected as in the rule.

5. Conductors carried along the exterior walls of buildings should in all cases be supported upon glass insulators, placed at least ten inches apart and so arranged as to be liable to abrasion from cornices, metallic shutters and the like. Special means should be provided to prevent accumulations of ice upon such conductors.

6. Conducting wires conveying currents, such as employed in electric-lighting and power, and which are in proximity to other wires, should be so secured or guarded as to prevent any possibility of contacts between the wires in case of accidents to the wires or their supports.

7. All conductors carried underground should be encased in lead, and preferably located in conduits made of a material which is non-porous to gas or water, non-inflammable and of good insulating character.

III. — Rules to be observed to prevent accidents to life.

1. No work of any sort, kind or description should be done upon an electric circuit whereon the E. M. F. of the current flowing exceeds fifty volts for alternating currents, and two hundred volts for continuous currents.

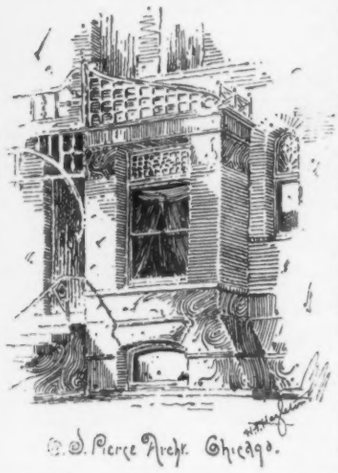
2. Where it is necessary to repair any portion of the line or fixtures, or lamps or other translating devices contained therein or thereon, and the current be flowing thereon, such portion of the line or fixture must first be cut out of circuit by means of a suitable cut-out, which shall be in electrical connection with a visual or audible tell-tale device, to show or make evident by sound that no current is flowing on the line.

3. Where bare conductors are employed for the transmission of power, they should rest upon insulating supports, and be provided with an insulating covering for at least two feet each side of the support.

4. Long lines having a number of arc-lights in series should be provided with a shunt and suitable cut-out switch around every five lamps.

Maple Flooring.— "Maple flooring," the New York gentleman remarked, "does not receive the attention in our market that it deserves. The architects are decidedly hard-headed. Of all men they should be progressive and up to the times, but they linger by the way in a provoking manner. They have been used to yellow-pine flooring, and yellow-pine flooring it must be to the end of the law. Now as between the two kinds of flooring, maple and yellow pine, I consider maple much superior in most cases. Especially when trucks are run over the floor, or it is otherwise subject to heavy work, maple leads so far that yellow pine is nowhere. Keep a maple floor damp, and the heavier the business done on it the harder the boards become. The wear there is in it is simply astonishing. The architects, however, seem to care little for that. They go on, on in the same old rut. If the use of maple for flooring were an experiment there might be some excuse for this pigheadedness, but it is no experiment. It has been tried and not found wanting in a single respect." — *Northwestern Lumberman.*

THE FACADE OF THE CATHEDRAL AT FLORENCE.



THE character of the work done at Venice supplies no rule for the judgment of what was to be done at Florence, especially on the Duomo, which, with St. Mark's, must, so far as artistic and historical interests are concerned, be placed in the first places in importance of all Italian churches. The problem in Santa Maria del Fiore has been doubled, involving not merely restoration but completion. The history of the façades of the cathedral has never been thoroughly searched out, and may some day be the subject of an interesting monograph, in which we shall learn to regret the way in which revolutions of taste in Italy abolished the genuine old, to substitute spurious new ideals, and of which we have an indication in a passage of Rondinelli, writing of the Duomo: "There was a façade of Gothic architecture (*Tedesca*) carried up about to the half-way, full of most beautiful niches intended for statues, which later were put in place; some were by the famous Donatello and some by other sculptors, artistically done, with most beautiful orders disposed and divided. There one saw several chapels introduced, divided and sustained by most beautiful and varied columns, some smooth and some twisted, so that, what with the variety of marbles and porphyries and the difference of the statues and columns, it had a very rich appearance and filled with majesty the sight of the beholder."

Then follows a detailed description of what had been done and of the statues of the historical personages introduced, and the opinion as to its general worth that it was equal to its position on the cathedral, but in 1587, being regarded by the classicists of the day as barbarous, it was destroyed, as Rondinelli says, so brutally that "there was no piece of marble that was got out entire; even the columns were broken, which was, in truth, a pitiful spectacle, first in the destruction of the façade, and, secondly, in the breaking of those beautiful marbles and porphyries, worked with so much cunning that if they had been taken out whole they would have served for ornaments in many other places with advantage to the works, which would have been able to sell them for some hundreds of scudi."

What consolation there is in proving that former and presumably more æsthetic generations were really more barbarous and tasteless than this we can here obtain and have the grim satisfaction of uttering maledictions on the Florentines of the end of the sixteenth century, as on the Venetians who, in the beginning of the thirteenth, melted the statues of Lysippus to coin money for their soldiers, and later destroyed the Parthenon car of Minerva; the French, who demolished scores of churches in Venice, and the ecclesiastical authorities who have covered Italian basilicas with the garniture and bad painting of the seventeenth century and whitewashed the frescos of Giotto and his successors for a hundred years or more. There is really no room for outcry if this generation should at most remove the disguisement of time and decay and restore to us the noble works left by great epochs of art in a state approximating to that in which they were completed.

The completion at length of the façade of the Duomo of Florence, which will be unveiled with great ceremony next spring, gives a peculiar appositeness to this and all other questions raised by the process of restoration, because we have here a church constructed by the greatest masters of architecture and sculpture of the Florentine Renaissance, peculiar in style, unique in construction, left to our day wanting its most attractive feature, the front; and this generation has determined that the work left incomplete shall now be completed with the best talent, whatever that may be, which Italy can furnish, and that the problem of how far this new and therefore necessarily crude surface juxtaposed with the old and time-toned, shall be harmonized with this.

It is premature to pronounce judgment on the work of de Fabris, to whom, after an exhaustive competition, the work was assigned in 1867, until it has been exposed entire to the deliberations of taste for a period sufficiently long to secure a firm judgment; but during a brief partial uncovering of the work in progress I was able to see enough of it to venture the opinion that it will be found, as a whole, quite in harmony with the body of the cathedral, and in itself a work which will do honor to the state of the arts in Italy and convince the outside world that that state is nobler than is generally believed. All the most eminent sculptors of Italy have competed for the honor of contributing the statues which fill the niches, the owners of all the quarries whence was taken the stone have offered the marbles needed, and so on with all the material, either gratuitously or at the cost of production, while the purely decorative work has been done by the Tuscan stone-cutters, whose business it is to do this kind of work at wages rarely much exceeding a shilling a day, the funds being furnished by voluntary contributions from the nation and the strangers interested in Florence (in connection with which I may note *en passant* a curious exception to the result of architects' calculations: the original estimate was for 1,500,000 francs, and the work will cost about 1,000,000 francs!)

The concentration on the façade of all the best talent of Italy, aided by the contributions of the entire kingdom, and resulting in a work which is maintained by some of my friends to be really one of the greatest, if not the greatest, of modern works in decorative architecture, gives the new element an importance in the question of harmonizing the parts for which we have no analogical term in the debates on St. Mark's, where no important part was new or merited to weigh *per se* in the balance. The desire of the Florentines to see their Duomo complete, but fresh and new as from the hands of the first builders, glistening like a bride-cake, is comprehensible, for the new as much as the old is their pride, and the general public opinion of the city would, I believe, like to see the surface entirely renewed, so as to be in keeping with the façade. And so far as this architecture pure and simple goes, there is this consideration of great weight urged by Signor del Moro, the architect who has succeeded de Fabris, that the designers of the church made one of the principal features of the design the employment of broad, flat surfaces with the relief and motive of the general decoration given by color, and to this end they employed a ground of white marble relieved with a deep green broken by red. Time and the slow accumulation of incrustations of dust and dirt, with the decomposition of the marble, have degraded the whites to a dingy gray, almost brown, and veiled the dark green to an extent that quite obscures the color, and in many passages it is difficult to see the line of demarcation between them. Under such conditions it is impossible to realize the idea of the designer, who made his decoration depend on colors which are no longer visible. Therefore, says del Moro, we must clean this surface of all the incrustations and deposits and bring out the color of the material, not, indeed, as when it was newly cut, but with that tone alone which age would give it. This idea has prevailed in the restorations, and the whole south flank, from the point where the skinning was stopped several years ago, has been carefully washed with brush and water, all the salient lines and sculptured detail being relieved of the dirt gathered by their projecting surfaces, excepting the gate of the Pisiani, which is reserved for later treatment.— *Letter from Florence to the London Times.*

COMMUNICATIONS.

FRENCH ARCHITECTURAL JOURNALS.

ST. LOUIS, MO., January 14, 1887.

TO THE EDITORS OF THE AMERICAN ARCHITECT:—

Dear Sirs,— What French journal (architectural) contains the best and most illustrations of French architecture? What is the name of the official organ of the leading French architectural society or association? By giving your opinion on the above questions you will greatly oblige one of your subscribers.

Yours truly, FRED. W. FOLK.

[LA REVUE GENERALE DE L'ARCHITECTURE, a monthly publication, is the best, both in quality and quantity. The best of the weekly journals is *La Construction Moderne*, edited by M. Paul Planat, formerly managing editor of *La Semaine des Constructeurs*, also a most excellent journal. The official publication of the leading French society is the *Bulletin Mensuel de la Société Centrale des Architectes.* —EDS. AMERICAN ARCHITECT.]

NOTES AND CLIPPINGS.

THE SOUND TUNNEL BETWEEN DENMARK AND SWEDEN.— Some two or three weeks back it was currently reported that the committee engaged in examining the scheme for a tunnel under the Sound between Denmark and Sweden, had arrived at the decision that they could not recommend it to their respective governments. This, however, is not correct, although possibly one or several members of the committee may have expressed themselves in a way that tended to circulate the above rumor. Under these circumstances a short authentic account of the exact state of affairs may not be without interest. When the representatives of the French company, who are starting the project — Messrs. Deloncle and Rothe — saw this rumor in the Scandinavian newspapers, they first applied to the Danish Government, and later, on the direction of the former, to the Swedish Government for a confirmation or denial of the same. It has now transpired that no definite report had been received by the Government. The gentlemen with whom Messrs. Deloncle and Rothe conferred in Stockholm, and of whom one or two were ministers of state, appeared to take a favorable view of the tunnel project, and as the difficulties were supposed to be more of a financial than of a technical nature, they expressed the desirability of obtaining more exhaustive statistical information as to the traffic, etc This has now been collected, and it appears that the present traffic between Sweden or Denmark, or even the traffic between Malinö and Copenhagen, is sufficient to insure the financial success of the scheme. And there is, of course, no doubt that the present traffic will be very considerably increased should the project become reality. This having been ascertained, the two engineers returned to Copenhagen,

where they have conferred with the Prime Minister as well as the Minister for the Interior, both of whom have expressed themselves in favor of the scheme. The results of the latest negotiations are, that the Danish and Swedish Governments are in favor of the tunnel — if it be realized — being built by a private company, but that the traffic, when it is ready, should be worked and managed by the State railways of the two countries; that they have no objections to the plan itself, nor to the respective governments helping the undertaking with money during the building of the tunnel, and that this should be taken over by the State when finished, provided the necessary Parliamentary sanction be obtained. Steps are now being taken for the immediate working out of more detailed plans, and it is anticipated that these may be forthcoming as early as January next year. As already mentioned no serious technical difficulties are anticipated, and altogether the prospects of the scheme seem to be all the promoters can desire. As to the probable terms of payment, these, of course, entirely depend upon future negotiations, but the French company seem to anticipate a series of payments on account, when portions of the tunnel are completed. The entire working would, of course, be superintended by gentlemen appointed by the respective governments. — *Engineering.*

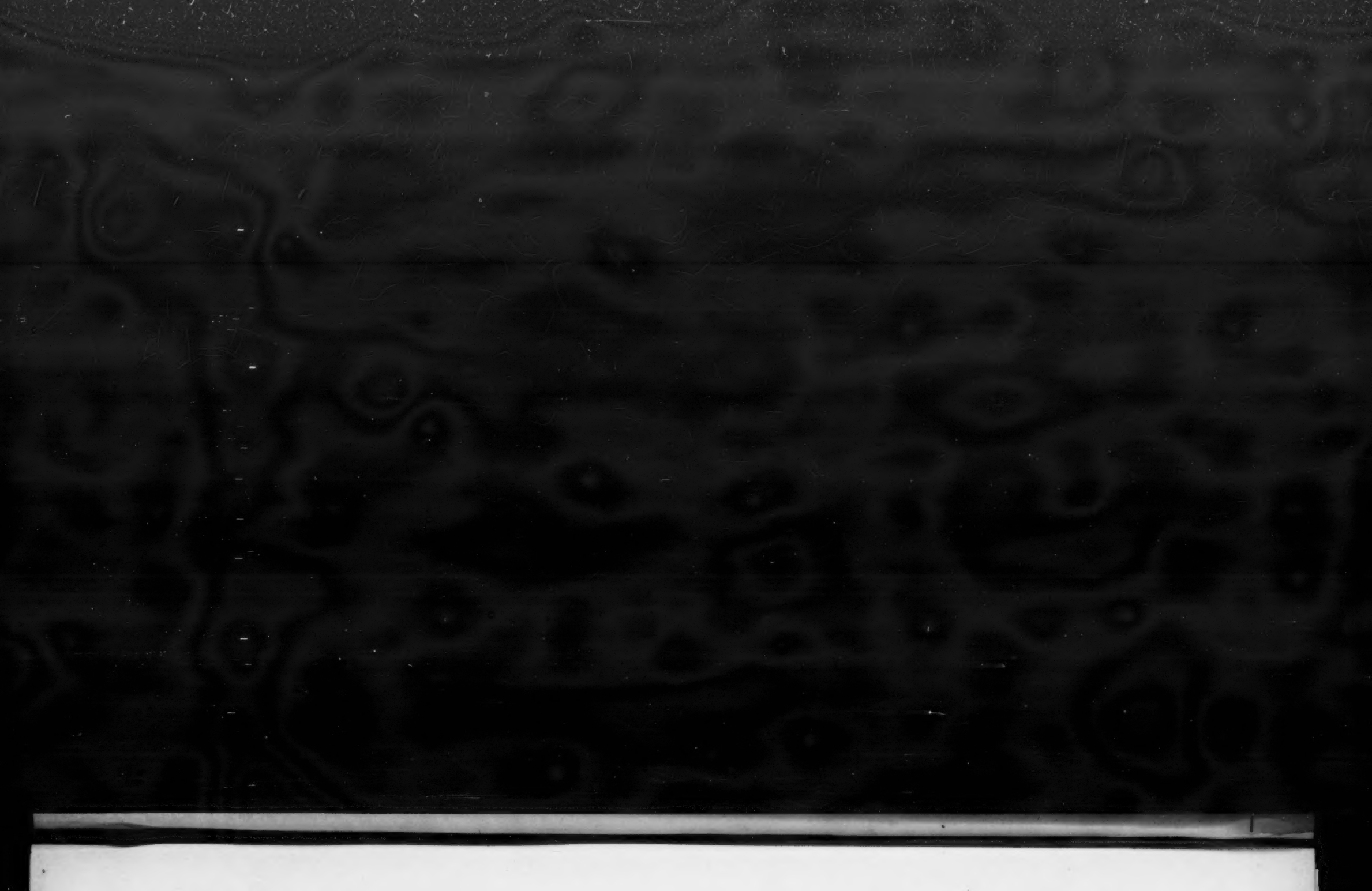
Mexican Windows. — Mexicans seem to entertain the idea that windows were made to look in at as well as to look out of, and it is a matter of daily occurrence for men, women and children of the *gamin* order, including peddlers and professional beggars, to congregate outside the bars and stand calmly staring in at us by the hour. The first sight of these barred windows strikes the stranger in Mexico rather unpleasantly, and he is apt to fancy himself in prison behind them, with his iron bedstead and brick floor for suitable accessories. In time, however, he realizes not only the conveniences but the necessity of them, and by and by feels an uneasy sense of insecurity if by some rare chance he finds himself not thus protected. The greater portion of Mexico is a land of perpetual summer, where windows must be open both night and day, and these gratings cannot be "picked" like locks, or noiselessly cut like panes of glass. But though one may sleep here in perfect security without closing a shutter, it is well to move one's effects from proximity to the windows — for the *ladrones* have a habit of throwing in ropes with hooks attached and dexterously drawing out even your garments — from which practice, perhaps, originated the Texan slang word "hooking" for stealing. It is only justice to add that there is far less thieving going on in Mexico, in proportion to population, than in our own country, for the influence of Roman Catholicism is paramount, especially among the poorer classes. I venture to assert that with all your spring-bolts and careful precautions to bring in even the door-mats at nightfall there is more stealing done in any northern city in a single day than in all Mexico in a year's time. — *Correspondence Philadelphia Record.*

Collapse of a Turbine Penstock. — Wherever wooden tubes are used for supplying turbine water-wheels, instances of rupture occur by bursting of the tubes by the impact of the suddenly arrested water when the gates of the wheel are closed suddenly. At a paper-mill in New Jersey occurred the unusual accident of the collapsing of an iron penstock tube five feet in diameter, built of five-sixteenths inch boiler iron. This tube was about seventy-five feet long, and descended at an inclination of 45° until it reached the turbine at a depth of fifty-two feet, and then this was followed by a draught-tube eight feet long, reaching below the turbine, making the total fall sixty feet. For a number of years the water had been admitted and closed from the turbine by the gates around the wheel, until, for some repairs, the water was shut from the penstock by the gates at the upper end. As the water sank in the tube there was a vacuum formed in the upper portion exceeding about thirty-three feet above the tail race, and the tube collapsed at once, the iron tearing off some of the riveted seams, and the two sides reaching to within a foot or so from each other. Although this result was quite expected by those in charge of the turbine, the application of Sir William Fairbairn's confessedly approximate rule, gives as a result a collapsing strength of seventeen and one-half pounds to the square inch, with a recommendation of a factor-of-safety of six, which would reduce the safe pressure to say three pounds. In the new penstock which was put in place in the destroyed one, there were three open vertical vent-tubes six inches or more in diameter, for the purpose of preventing a recurrence of the disaster, which was, in the first place, wholly inexcusable in view of the general knowledge, and of the engineering practice on the subject. — *Engineering.*

Popular Notions regarding Steam. — In the *Saturday Post* of October 23, 1886, a Greenock paper, the following appears:

The Pressure of Steam. — "Steam, as compared to water, occupies 1728 times as much space. A cubic inch of water will make 1728 inches of steam at atmospheric pressure. Now, if this steam is compressed into half that space it will give double pressure, or 15 lbs. above the atmosphere; and it will then occupy only 864 cubic inches. If reduced again to half its volume, it will occupy 432 cubic inches, and will give 30 lbs. pressure to the square inch. Reduced again to half the volume, the steam will occupy 216 cubic inches, and will give 60 lbs. pressure to the square inch. We can go on reducing in this way until we find that a cubic inch of water turned into steam, and compressed into a space of 3 cubic inches, will give the enormous pressure of 3840 lbs. to the square inch."

Greenock occupies a high position in regard to the science of steam; it is the birthplace of Watt, and it has turned out a greater horse-power of marine steam-engines than any other town of its size in the world. Notes about steam served out in the Greenock papers on Saturdays for Sunday meditation ought therefore to be worth reading. Let us take the above extract bit by bit. "Steam as compared to water occupies 1728 times as much space." Only at one pressure is this true, and that is not at atmospheric pressure, the relative volume is then, say, 1648. "Compressed into half that space it will give double pressure, or 15 lbs. above the atmosphere." If we could have steam at that pressure, but still at the temperature of "boiling water," 212° Fahrenheit, then might the pressure be as stated, but steam at twice the pressure must be at its own higher temperature, and therefore its volume must be more than "compressed into half that space." "Reduced again to half the volume. . . . 30 lbs. pressure to the square inch." In addition to the temperature objection there is now an atmospheric objection to this statement. Pressures are stated either as above the atmospheric pressure or as including the pressure of the atmosphere, but the writer of the Greenock note seems to have now forgotten the atmosphere altogether. The pressure he has now attained by doubling is 60 lbs. gross, or 45 lbs. above the atmosphere, and not by any way of looking at it can it be 30. The note goes on doubling and doubling in this way, getting 15, 30, 60 x 64 = 3840 lb. per square inch, instead of 15, 45, 105, 120 x 64 = 7665 + 15. As this Greenock note contains quite unconsciously so many common errors its correction may prove useful. — *Engineering.*

TRADE SURVEYS

Some of our most careful building authorities who have recently expressed the opinion that the other side of the industrial activity has been overlooked mean, in a word, this: that the improvement in prices and the prospects for the very general employment of capital and labor during 1887 will stimulate building activity. They manifest their confidence in their opinion by arranging already for large supplies of material of all kinds at current prices. They argue that what has taken place in the iron and steel industries on a large scale will certainly take place in the building trades on a smaller scale, and that the record of 1886 as to building operations will be exceeded in 1887. There are those who take a more gloomy view of building prospects and entertain, no doubt honestly, the opinion that the advance in real estate which seems to be quite general, and the advance in building materials of all kinds, will act as a retarding influence to building enterprises. While it is early in the season to indulge in prognostications it can be said that so far, at least, the course pursued by builders and projectors of large enterprises is in favor of the first class of reasoners. Future probabilities trouble builders and manufacturers very little. They are quietly proceeding upon a safe basis, that is, buying material enough to cover contracts either in hand or contracts which they have every reason for believing will come to them as soon as the proper time arrives. It is true that real estate, both urban and suburban, has advanced, particularly in the Middle and Western States. Advances have been made in certain favorable localities in the South, but as a rule property is still cheap, and this fact accounts for the anxiety of large capitalists to make investments in that section. No doubt a very large amount of money will be invested in localities this year where the spirit of enterprise is expected to sweep like a cyclone in order that the investors may profit by an early advance. It has taken place at Birmingham, Annistown, South Pittsburgh, Chattanooga, Atlanta, and a few other Southern towns, and is expected by the sanguine investors to take place in many other towns this year and next. Away off in Los Angeles, California, and in two or three other towns in that locality, a real-estate boom has set in. The accounts of it have even reached the far East. There are also some localities in Texas, Kansas, and Missouri, where real estate has taken a sudden bound upward, as, for instance, at Kansas City, and Austin, which is serving as a hint to possessors of large blocks of money to transplant it from idleness in Eastern financial centres to Western fields of enterprise. As before observed the basis of this activity is to be found in the extraordinary railroad building. This confidence is gaining ground every week, even in midwinter, and the formation of syndicates continues to be announced, having for their objective point the purchasing of land either for speculative purposes or for investment in reproductive channels. All of the industries are thriving, and in jobbing circles business has begun to feel the effect of the movement of the army of drummers for the spring trade. Dry-goods manufacturers have proved their wisdom in improving their facilities for production, and within a week a great many concerns throughout the New England States have resumed full time. The output of our textile mills during the first quarter of the year will largely exceed that of the first quarter of last year; how much it would be guesswork to say. The makers of wood-working machinery report continued improvement and better prices than have prevailed. The tool-makers and machine-makers have also good reports to make concerning new orders and spring and summer trade prospects. Locomotive-makers have, or within a week or two will have, closed contracts for somewhere between 800 and 1,000 locomotive engines. The railroad-managers are now engaged in completing their estimates for engines, cars, and material of all kinds, and it is safe to say that during the rest of this month and February a large volume of business will be crowded in upon the makers of railroad supplies and equipments to be furnished between now and July 1. Even with all the activity that has prevailed in the car works throughout the country, the trunk lines especially, and scores of other smaller roads are deficient in rolling stock. The smaller industrial establishments are finding orders crowding in. The improvement in prices is legitimate and conservative. The producers and manufacturers of the country show no desire to crowd prices into the speculative arena. The iron and steel makers are asking higher prices than a week ago, and, as recently stated, business has been checked somewhat though all know that a heavy demand must be shortly provided for and that the high range of prices will hold for an indefinite time to come. The anthracite coal trade has been checked somewhat by a strike which, at present writing, shows very little signs of weakening. The lumber trade is in winter quarters. The boot and shoe manufacturers expect to produce more goods this winter than last, and their travelling agents report bare markets throughout the West. In certain branches of the textile trade as, for instance, in the cashmeres and worsteds, prices will advance from five to ten per cent. These indications of an upward tendency are calculated to increase the feverishness in all markets, but consumers keep this one fact in mind, that the productive capacity is ample, and that it is only a matter of time when the enormous production will overtake demand and create probably a reaction in prices. The failures occurring since the opening of the year are comparatively few in number. The financial condition is strong and an abundance of money is stored in Eastern centres with very little demand from the West. No new questions are arising to disturb the confidence of producers and exchangers in financial, railway, or other problems. The laborers are acting with conservatism and will probably enter upon the new year with understandings which will avoid the recurrence of the strikes which so seriously unsettled confidence in building during the early part of last year.